University of Mumbai

No. UG/ 49 of 2021

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus directly uploaded by the Academic Authority Unit which was accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No.4.180 relating to the revised syllabus as per the (CBCGS) for Bachelor of Engineering (Information Technology) Second Year w.e.f. AY 2017-18, Third Year w.e.f. AY 2018-19 and Final Year w.e.f. AY 2019-20 (Rev – 2016) from Academic Year 2016-17.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Information Technology at its meeting held on 24th April, 2020 and subsequently made by the Board of Deans at its meeting held on 26th June, 2020 vide item No. 14(10) have been accepted by the Academic Council at its meeting held on 23rd July, 2020 **vide** item No. 4.126 and that in accordance therewith, the Scheme (Sem. III to VIII) and revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Information Technology (Sem.III & IV) has been brought into force with effect from the academic year 2020-21. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
21st January, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.126/23/07/2020

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No. UG/ 49 -A of 2021 MUMBAI-400 032 21st January, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Information Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC: 23/7/2020
Item No4126

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Information Technology Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	8 semesters
6	Level	~~P.G.~~ / U.G./~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	New / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date :23/7/2020

AMajumdar
Dr. Anuradha Majumdar

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

AC: 23/7/2020

Item No. : 126

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 23/7/2020
Item No. 126

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Information Technology Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date: 23/7/2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

It is our honor and a privilege to present the Rev-2019 ‘C’ scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology Engineering - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)
Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ITC302	Data Structure and Analysis	3		--	3		--	3
ITC303	Database Management System	3	--	--	3	--	--	3
ITC304	Principle of Communication	3	--	--	3	--	--	3
ITC305	Paradigms and Computer Programming Fundamentals	3	--	--	3	--	--	3
ITL301	Data Structure Lab	--	2	--	--	1	--	1
ITL302	SQL Lab	--	2	--	--	1	--	1
ITL303	Computer programming Paradigms Lab	--	2	--	--	1	--	1
ITL304	Java Lab (SBL)	--	4	--	--	2	--	2
ITM301	Mini Project – 1 A Front end /backend Application using JAVA	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg.					
ITC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ITC302	Data Structure and Analysis	20	20	20	80	3	--	--	100
ITC303	Database Management System	20	20	20	80	3	--	--	100
ITC304	Principle of Communication	20	20	20	80	3	--	--	100
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	3	--	--	100
ITL301	Data Structure Lab	--	--	--	--	--	25	25	50
ITL302	SQL Lab	--	--	--	--	--	25	25	50
ITL303	Computer programming Paradigms Lab	--	--	--	--	--	25	25	50
ITL304	Java Lab (SBL)	--	--	--	--	--	25	25	50
ITM301	Mini Project – 1 A Front end /backend Application using JAVA	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B Python based automation projects	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract.**	**Theory**	**Pract.**	**Total**
ITC501	Internet Programming	3	--	3	--	3
ITC502	Computer Network Security	3	--	3		3
ITC503	Entrepreneurship and E- business	3	--	3	--	3
ITC504	Software Engineering	3	--	3	--	3
ITDO501X	**Department Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL501	IP Lab	- -	2	--	1	1
ITL502	Security Lab	- -	2	--	1	1
ITL503	DevOPs Lab	- -	2	--	1	1
ITL504	Advance DevOPs Lab	-	2	--	1	1
ITL505	Business Communication and Ethics	- -	2*+2	--	2	2
ITM501	Mini Project – 2 A Web Based Business Model	- -	$4^{\$}$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC501	Internet Programming	20	20	20	80	3	--	--	100
ITC502	Computer Network Security	20	20	20	80	3	--	--	100
ITC503	Entrepreneurship and E- business	20	20	20	80	3	--	--	100
ITC504	Software Engineering	20	20	20	80	3	--	--	100
ITDO501X	**Department Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL501	IP Lab	--	--	--	--	--	25	25	50
ITL502	Security Lab	--	--	--	--	--	25	25	50
ITL503	DevOPs Lab	--	--	--	--	--	25	25	50
ITL504	Advance DevOPs Lab	--	--	--	--	--	25	25	50
ITL505	Business Communication and Ethics	--	--	--	--	--	50	--	50

ITM501	Mini Project – 2 A Web Based Business Model	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**125**	**800**

* Theory class to be conducted for full class

$ indicates work load of Learner (Not Faculty), for Mini Project

ITDO501X	**Department Optional Course – 1**
ITDO5011	Microcontroller Embedded Programming
ITDO5012	Advance Data Management Technologies
ITDO5013	Computer Graphics & Multimedia System
ITDO5014	Advanced Data structure and Analysis

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC601	Data Mining & Business Intelligence	3	--	3	--	3
ITC602	Web X.0	3	--	3		3
ITC603	Wireless Technology	3	--	3	--	3
ITC604	AI and DS – 1	3	--	3	--	3
ITDO601 X	**Department Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL601	BI Lab	--	2	--	1	1
ITL602	Web Lab	--	2	--	1	1
ITL603	Sensor Lab	--	2	--	1	1
ITL604	MAD & PWA Lab	--	2	--	1	1
ITL605	DS using Python Skill based Lab	--	2	--	1	1
ITM601	Mini Project – 2 B Based on ML	--	$4^{\$}$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100
ITC602	Web X.0	20	20	20	80	3	--	--	100
ITC603	Wireless Technology	20	20	20	80	3	--	--	100
ITC604	AI and DS – 1	20	20	20	80	3	--	--	100
ITDO601 X	**Department Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL601	BI Lab	--	--	--	--	--	25	25	50
ITL602	Web Lab	--	--	--	--	--	25	25	50
ITL603	Sensor Lab	--	--	--	--	--	25	25	50
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50
ITL605	DS using Python Lab (SBL)	--	--	--	--	--	25	25	50

ITM601	Mini Project – 2 B Based on ML	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini Project

ITDO601X	**Department Optional Course – 2**
ITDO6011	Software Architecture
ITDO6012	Image Processing
ITDO6013	Green IT
ITDO6014	Ethical Hacking and Forensic

Program Structure for Fourth Year Engineering
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	--	3
ITC702	Internet of Everything	3	--	3		3
ITDO701 X	**Department Optional Course – 3**	**3**	**--**	**3**	**--**	**3**
ITDO702 X	**Department Optional Course –4**	**3**	**--**	**3**	**--**	**3**
ITIO701X	**Institute Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL701	Data Science Lab	--	2	--	1	1
ITL702	IOE Lab	--	2	--	1	1
ITL703	Secure Application Development	--	2	--	1	1
ITL704	Recent Open Source Project Lab	--	2	--	1	1
ITP701	Major Project I	--	$6^{\#}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC701	AI and DS –II	20	20	20	80	3	--	--	100
ITC702	Internet of Everything	20	20	20	80	3	--	--	100
ITDO701 X	**Department Optional Course –3**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO702 X	**Department Optional Course –4**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO701X	**Institute Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL701	Data Science Lab	--	--	--	--	--	25	25	50
ITL702	IOE Lab	--	--	--	--	--	25	25	50
ITL703	Secure Application Development	--	--	--	--	--	25	25	50
ITL704	Recent Open Source Project Lab	--	--	--	--	--	25	25	50
ITP701	Major Project I	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

# indicates work load of Learner (Not Faculty), for Major Project

ITDO701X	**Department Optional Course –3**
ITDO7011	Storage Area Network
ITDO7012	High Performance computing
ITDO7013	Infrastructure Security
ITDO7014	Software Testing and QA

ITDO702X	**Department Optional Course –4**
ITDO7021	MANET
ITDO7022	AR – VR
ITDO7023	Quantum Computing
ITDO7024	Information Retrieval System

ITIO701X	**Institute Optional Course – 1 (Common for all branches will be notified)**

Program Structure for Fourth Year Engineering
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract. Tut.**	**Theory**	**Pract.**	**Total**
ITC801	Blockchain and DLT	3	--	3	--	3
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL801	Blockchain Lab	--	2	--	1	1
ITL802	Cloud computing	--	2	--	1	1
ITP801	Major Project II	--	$12^{\#}$	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC801	Blockchain and DLT	20	20	20	80	3	--	--	100
ITDO801X	**Department Optional Course – 5**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO802X	**Department Optional Course – 6**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO801X	**Institute Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL801	Blockchain Lab	--	--	--	--	--	25	25	50
ITL802	Cloud computing	--	--	--	--	--	25	25	50
ITP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

ITDO801X	**Department Optional Course – 5**
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	**Department Optional Course –6**
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

ITIO801X	**Institute Optional Course – 2 (Common for all branches will be notified)**

AC: **23/7/2020**

Item No. : **126**

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 23/7/2020
Item No. 126

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Information Technology Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date :23/7/2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

It is our honor and a privilege to present the Rev-2019 ‘C’ scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology Engineering - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)
Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(**With Effect** from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ITC302	Data Structure and Analysis	3		--	3		--	3
ITC303	Database Management System	3	--	--	3	--	--	3
ITC304	Principle of Communication	3	--	--	3	--	--	3
ITC305	Paradigms and Computer Programming Fundamentals	3	--	--	3	--	--	3
ITL301	Data Structure Lab	--	2	--	--	1	--	1
ITL302	SQL Lab	--	2	--	--	1	--	1
ITL303	Computer programming Paradigms Lab	--	2	--	--	1	--	1
ITL304	Java Lab (SBL)	--	4	--	--	2	--	2
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	4$^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test2**	**Avg.**					
ITC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ITC302	Data Structure and Analysis	20	20	20	80	3	--	--	100
ITC303	Database Management System	20	20	20	80	3	--	--	100
ITC304	Principle of Communication	20	20	20	80	3	--	--	100
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	3	--	--	100
ITL301	Data Structure Lab	--	--	--	--	--	25	25	50
ITL302	SQL Lab	--	--	--	--	--	25	25	50
ITL303	Computer programming Paradigms Lab	--	--	--	--	--	25	25	50
ITL304	Java Lab (SBL)	--	--	--	--	--	25	25	50
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups.

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC301	Engineering Mathematics-III	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC301	Engineering Mathematics-III	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2	To acquaint with the concept of Fourier series, its complex form and enhance the problem solving skills.
3	To familiarize the concept of complex variables, C-R equations with applications.
4	The fundamental knowledge of Trees, Graphs etc.
5	To study the basic techniques of statistics like correlation, regression and curve fitting for data analysis, Machine learning and AI.
6	To understand some advanced topics of probability, random variables with their distributions and expectations.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply the concept of Laplace transform to solve the real integrals in engineering problems.	L1, L2
2	Apply the concept of inverse Laplace transform of various functions in engineering problems.	L1, L2

3	Expand the periodic function by using Fourier series for real life problems and complex engineering problems.	L1, L2, L3
4	Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.	L1, L2, L3
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.	L2, L3
6	Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.	L1, L2

Module	**Detailed Contents**	**Hours**	**CO Mapping**
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of real integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	7	CO1
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives, 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations	6	CO1, CO2
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity(without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	7	CO3

04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	7	CO4
05	**Module: Statistical Techniques** 5.1 Karl Pearson's Coefficient of correlation (r) 5.2 Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks) 5.3 Lines of regression 5.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6	CO5
06	**Module: Probability** 6.1 Definition and basics of probability, conditional probability, 6.2 Total Probability Theorem and Baye's theorem 6.3 Discrete and continuous random variable with probability distribution and probability density function. 6.4 Expectation of random variables with mean, variance and standard deviation, moment generating function up to four moments. **Self-learning Topics:** Skewness and Kurtosis of distribution (data)	6	CO6

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
5. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
6. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC302	Data Structure and Analysis	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC302	Data Structure and Analysis	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	The fundamental knowledge of data structures.
2	The programming knowledge which can be applied to sophisticated data structures.
3	The fundamental knowledge of stacks queue, linked list etc.
4	The fundamental knowledge of Trees, Graphs etc.
5	The fundamental knowledge of different sorting, searching, hashing and recursion techniques
6	The real time applications for stacks, queue, linked list, trees, graphs etc.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Classify and Apply the concepts of stacks, queues and linked list in real life problem solving.	L1, L2, L3
2	Classify, apply and analyze the concepts trees in real life problem solving.	L2, L3,L4
3	Illustrate and justify the concepts of graphs in real life problem solving.	L3, L5
4	List and examine the concepts of sorting, searching techniques in real life problem solving.	L2, L3, L4
5	Use and identify the concepts of recursion, hashing in real life problem solving.	L3, L4
6	Examine and justify different methods of stacks, queues, linked list, trees and graphs to various applications.	L3, L4, L5

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Defining, Declaring and Initialization of structure variables. Accessing members of a structure, Array of structures, Nested structures, Pointers to structures. Passing structure, structure members, structure arrays and pointer to structure as function parameters. Self-referential structures.	**02**	---
I	Introduction to Stacks, Queues and Linked Lists	Introduction to Data Structures: Linear and Non Linear Data Structures, Static and Dynamic Data Structures. Concept of Stack and Queue. Array Implementation of Stack and Queue, Circular Queue, Double Ended Queue, Priority Queue. Concept of Linked Lists. Singly linked lists, doubly linked lists and circular linked lists. Insertion, deletion, update and copying operations with Singly linked lists, doubly linked lists and circular linked lists. Reversing a singly linked list. **Self-learning Topics:** Linked List Implementation of Stack, Linked List implementation of Queue, Circular Queue, Double Ended Queue, Priority Queue.	**08**	CO1
II	Trees	Introduction to Trees: Terminology, Types of Binary trees. Non recursive Preorder, in-order and post-order traversal. Creation of binary trees from the traversal of binary trees. Binary search tree: Traversal, searching, insertion and deletion in binary search tree. Threaded Binary Tree: Finding in-order successor and predecessor of a node in threaded tree. Insertion and deletion in threaded binary tree. AVL Tree: Searching and traversing in AVL trees. Tree Rotations: Right Rotation, Left Rotation. Insertion and Deletion in an AVL Tree. B-tree: Searching, Insertion, Deletion from leaf node and non-leaf node. B+ Tree, Digital Search Tree, Game Tree & Decision Tree **Self-learning Topics:** Implementation of AVL and B+ Tree	**07**	CO1, CO 2
III	Graphs	Introduction to Graphs: Undirected Graph, Directed Graph, graph terminology, Connectivity in Undirected and Directed Graphs. Spanning tree. Representation of graph: adjacency matrix, adjacency list, Transitive closure of a directed graph and path matrix.	**05**	CO1, CO3

		Traversals: Breadth First Search, Depth First Search. **Self-learning Topics:** Implementation of BFS, DFS		
IV	Recursion and Storage Management	Recursion: Writing a recursive function, Flow of control in recursive functions, Winding and unwinding phase, Recursive data structures, Implementation of recursion. Tail recursion. Indirect and Direct Recursion. Storage Management: Sequential Fit Methods: First Fit, Best Fit and Worst Fit methods. Fragmentation, Freeing Memory, Boundary Tag Method. Buddy Systems: Binary Buddy System, Fibonacci Buddy System. Compaction, Garbage Collection. **Self-learning Topics:** Implementation of recursion function.	**06**	CO5
V	Searching and Sorting	Searching: Sequential Search, Binary Search. Hashing: Hash Functions: Truncation, Mid-square Method, Folding Method, Division Method. Collision Resolution: Open Addressing: Linear Probing, Quadratic Probing, Double Hashing, Separate Chaining Bucket Hashing. Analysis of all searching techniques Sorting: Insertion sort, Selection sort, Merge sort, Quick sort and Radix sort. Analysis of all sorting techniques **Self-learning Topics:** Implementation of different sorting techniques and searching.	**05**	CO 4, CO5
VI	Applications of Data Structures	Applications of Linked Lists: Addition of 2 Polynomials and Multiplication of 2 polynomials. Applications of Stacks: Reversal of a String, Checking validity of an expression containing nested parenthesis, Function calls, Polish Notation: Introduction to infix, prefix and postfix expressions and their evaluation and conversions. Application of Queues: Scheduling, Round Robin Scheduling Applications of Trees: Huffman Tree and Heap Sort. Applications of Graphs: Dijkstra’s Algorithm, Minimum Spanning Tree: Prim’s Algorithm, Kruskal’s Algorithm. **Self-learning Topics:** Implementation of applications for Stack, Queues, Linked List, Trees and Graph.	**06**	CO6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Online References:

Sr. No.	Website Name
2.	https://www.nptel.ac.in
3.	https://opendatastructures.org/
3.	https://www.coursera.org/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC303	Database Management System	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC303	Database Management System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To learn the basics and understand the need of database management system.
2	To construct conceptual data model for real world applications
3	To Build Relational Model from ER/EER.
4	To introduce the concept of SQL to store and retrieve data efficiently.
5	To demonstrate notions of normalization for database design.
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Identify the need of Database Management System.	L1, L2
2	Design conceptual model for real life applications.	L6
3	Create Relational Model for real life applications	L6
4	Formulate query using SQL commands.	L3
5	Apply the concept of normalization to relational database design.	L3
6	Demonstrate the concept of transaction, concurrency and recovery.	L2

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	**Comment**Basic knowledge of operating systems and file systems, Any programming	**02**	--
I	**Database System Concepts and Architecture**	Introduction, Characteristics of Databases, File system v/s Database system, Data abstraction and Data Independence, DBMS system architecture, Database Administrator (DBA), Role of DBA **Self-learning Topics:** Identify the types of Databases.	**05**	CO1
II	**The Entity-Relationship Model**	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Weak entity Types Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model. **Self-learning Topics:** Design an ER model for any real time case study.	**05**	CO2
III	**Relational Model & Relational Algebra**	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for Unary Relational Operations, • Set Theory operations, • Binary Relational operation Relational Algebra Queries **Self-learning Topics:** Map the ER model designed in module II to relational schema..	**05**	CO3
IV	**Structured Query Language (SQL) & Indexing**	Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, nested Queries ; Integrity constraints in SQL. Database Programming with JDBC, Security and authorization: Grant & Revoke in SQL Functions and Procedures in SQL and cursors. Indexing:Basic Concepts, Ordered Indices, Index Definition in SQL **Self-learning Topics:** Physical design of database for the relational model designed in module III and fire various queries.	**08**	CO4

V	**Relational Database Design**	Design guidelines for relational Schema, Functional Dependencies, Database tables and normalization, The need for normalization, The normalization process, Improving the design, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF). **Self-learning Topics:** Consider any real time application and normalization upto 3NF/BCNF	**07**	CO5
VI	**Transactions Management and Concurrency and Recovery**	Transaction: Transaction concept, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling Timestamp-based protocols, Recovery System: Recovery Concepts, Log based recovery. **Self-learning Topics:** Study the various deadlock situation which may occur for a database designed in module V.	**07**	CO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ― Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.oreilly.com
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC304	Principle of Communication	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC304	Principle of Communication	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	Study the basic of Analog and Digital Communication Systems.
2	Describe the concept of Noise and Fourier Transform for analyzing communication systems.
3	Acquire the knowledge of different modulation techniques such as AM, FM and study the block diagram of transmitter and receiver.
4	Study the Sampling theorem and Pulse Analog and digital modulation techniques
5	Learn the concept of multiplexing and digital band pass modulation techniques
6	Gain the core idea of electromagnetic radiation and propagation of waves.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Describe analog and digital communication systems	L1,L2
2	Differentiate types of noise, analyses the Fourier transform of time and frequency domain.	L1, L2, L3, L4
3	Design transmitter and receiver of AM, DSB, SSB and FM.	L1,L2,L3,L4
4	Describe Sampling theorem and pulse modulation systems.	L1,L2,L3
5	Explain multiplexing and digital band pass modulation techniques.	L1, L2
6	Describe electromagnetic radiation and propagation of waves.	L1,L2

Prerequisite: Basic of electrical engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Terminologies in communication systems, analog and digital electronics	**02**	
I	**Introduction**	Basics of analog communication and digital communication systems (Block diagram), Electromagnetic Spectrum and application, Types of Communication channels. **Self-learning Topics:** Applications areas of analog and digital communication.	**03**	**CO1**
II	**Noise and Fourier Representation of Signal and System**	Basics of signal representation and analyses, Introduction to Fourier Transform, its properties (time and frequency shifting, Fourier transform of unit step, delta and gate function. Types of Noise, Noise parameters –Signal to noise ratio, Noise factor, Noise figure, Friss formula and Equivalent noise temperature. **Self-learning Topics:** Practice Numerical on above topic.	**06**	**CO2**
III	**Amplitude and Angle modulation Techniques.**	Need for modulation, Amplitude Modulation Techniques: DSBFC AM,DSBSC-AM, SSB SC AM- block diagram spectrum, waveforms, bandwidth, Power calculations. Generation of AM using Diode, generation of DSB using Balanced modulator, Generation of SSB using Phase Shift Method. AM Transmitter (Block Diagram) AM Receivers – Block diagram of TRF receivers and Super heterodyne receiver and its characteristics- Sensitivity, Selectivity, Fidelity, Image frequency and its rejection and double spotting **Angle Modulation** **FM:** Principle of FM- waveforms, spectrum, bandwidth. Pre- emphasis and de-emphasis in FM, FM generation: Direct method –Varactor diode Modulator, Indirect method (Armstrong method) block diagram and waveforms. FM demodulator: Foster Seeley discriminator, Ratio detector. **Self-learning Topics:** Use of AM and FM in Modern Communication Technology. Challenges faced by radio business.	**12**	**CO1, CO2, CO3**
IV	**Pulse Analog Modulation and Digital Modulation**	Sampling theorem for low pass and band pass signals with proof, Anti- aliasing filter, PAM, PWM and PPM generation and Degeneration. Quantization process, Pulse code modulation, Delta modulation, Adaptive delta modulation. Introduction to Line Codes and ISI.	**08**	**CO1, CO2, CO4**

		Self-learning Topics: Implementation of Pulse code modulation and demodulation.		
V	**Multiplexing and Digital Band Pass Modulation Techniques**	Principle of Time Division Multiplexing, Frequency Division Multiplexing , Orthogonal Frequency Division Multiplexing and its applications .ASK, FSK, PSK QPSK Generation and detection. **Self-learning Topics:** Implement TDM, FDM, OFDM.	**04**	**CO1, CO2, CO5**
VI	**Radiation and Propagation of Waves**	Electromagnetic radiation, fundamentals, types of propagation, ground wave, sky wave, space wave tropospheric scatter propagation **Self-learning Topics:** List the real time examples for different types of propagation waves.	**04**	**CO6**

Text Books:

[1]. George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed
[2]. Simon Haykin, Michael Moher, Introduction to Analog & Digital Communications, Wiley India Pvt. Ltd., 2nd Ed.
[3].Wireless Communication and Networking, Vijay Garg

References:
[1]. Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.
[2]. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University
[3]. Herbert Taub, Donald L Schilling, Goutam Saha, Principles of Communication Systems, Tata McGraw Hill, 3rdEd.
[4]. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.classcentral.com
3.	http://www.vlab.co.in/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC305	Paradigms and Computer Programming Fundamentals	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To introduce various programming paradigms and the basic constructs that underline any programming language.
2	To understand data abstraction and object orientation
3	To introduce the basic concepts of declarative programming paradigms through functional and logic programming.
4	To design solutions using declarative programming paradigms through functional and logic programming.
5	To introduce the concepts of concurrent program execution.
6	To understand use of scripting language for different problem domains

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand and Compare different programming paradigms.	L1, L2
2	Understand the Object Oriented Constructs and use them in program design.	L1, L2
3	Understand the concepts of declarative programming paradigms through functional and logic programming.	L1, L2
4	Design and Develop programs based on declarative programming paradigm using functional and/or logic programming.	L5, L6
5	Understand the role of concurrency in parallel and distributed programming.	L1, L2
6	Understand different application domains for use of scripting languages.	L1. L2

Prerequisite: Students must have learned C Programming (FEC205 and FEL204),

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Compilation and interpretation Focus on overview of compilation steps.	**02**	CO1
I	Introduction to Programming Paradigms and Core Language Design Issues	Introduction to different programming paradigms. Names, Scopes, and Bindings, Scope Rules, Storage Management. Type Systems, Type Checking, Equality Testing and Assignment. Subroutine and Control Abstraction: Stack Layout, Calling sequence, parameter passing Generic subroutines and modules. Exception handling, Coroutines and Events. **Self-Learning Topic:** Implementation of basic concepts using programming language.	**10**	CO1
II	Imperative Paradigm: Data Abstraction in Object Orientation	Grouping of data and Operations- Encapsulation, Overloading, Polymorphism, Inheritance, Initialization and Finalization, Dynamic Binding. **Self-Learning Topic:** Implementation of OOP concepts using preferrably C++ and Java language.	**05**	CO2
III	Declarative Programming Paradigm: Functional Programming	Introduction to Lambda Calculus, Functional Programming Concepts, Evaluation order, Higher order functions, I/O-Streams and Monads. **Self-Learning Topic:** Implementation of programs using functional programming Language Haskel can refer to hacker rank website for problem statements.	**07**	CO3, CO4
IV	Declarative Programming Paradigm: Logic Programming	Logic Programming with PROLOG - Resolution and Unification, Lists, Arithmetic execution order, imperative control flow, database manipulation, PROLOG facilities and deficiencies. **Self-Learning Topic:** Identification of different application domains for use of Prolog and Logic programming	**06**	CO3, CO4
V	Alternative Paradigms: Concurrency	Concurrent Programming Fundamentals, Implementing synchronisation, Message Passing - Background and Motivation, Multithreaded programs, Communication and Synchronization, Language and Libraries, Thread creation Syntax. **Self-Learning Topic:** Study Implementation of concurrency concepts for real time application.	**04**	CO5
VI	Alternative Paradigms: Scripting Languages	Common characteristics, Different Problem domains for using scripting,Use of scripting in Web development–server and clients side scripting, Innovative features of scripting languages - Names and Scopes, string and pattern manipulation, data types, object orientation.	**05**	CO6

		Self-Learning Topic: Review small client server application code in any scripting language to realise applicability of features learned in Module.		

Text Books:

1. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
2. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016
3. Programming Languages: Concepts and Constructs; 2nd Edition, Ravi Sethi, Pearson Education Asia, 1996.

References:

1. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2^{nd} Edition) (February 2, 2016)
2. Programming Languages: Design and Implementation (4th Edition), by Terrence W. Pratt, Marvin V. Zelkowitz, Pearson, 2000
3. Rajkumar Buyya, Object-oriented Programming with Java: Essentials and Applications, Tata McGraw Hill Education Private Limited
4. Max Bramer, Logic Programming with Prolog, Springer ISBN-13: 978-1852-33938-8

Online References:

Sr No	Website Name	Link
1	Principles of programming Languages (Videos)	https://nptel.ac.in/courses/106/102/106102067/
2	Edx course Paradigms of Computer Programming – Fundamentals	https://www.classcentral.com/course/edx-paradigms-of-computer-programming-fundamentals-2298
3	Udemy Couses	https://www.udemy.com

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

► **Question paper format**

- Question Paper will comprise of a total of six questions each carrying 20 marks Q.1 will be compulsory and should cover maximum contents of the syllabus.
- Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of four questions need to be answered

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL301	Data Structure Lab	--	02	--	--	01	--	01

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL301	Data Structure Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To use data structures as the introductory foundation for computer automation to engineering problems.
2	To use the basic principles of programming as applied to complex data structures.
3	To learn the principles of stack, queue, linked lists and its various operations.
4	To learn fundamentals of binary search tree, implementation and use of advanced tree like AVL, B trees and graphs.
5	To learn about searching, hashing and sorting.
6	To learn the applications of linked lists, stacks, queues, trees and graphs.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand and use the basic concepts and principles of various linked lists, stacks and queues.	L1, L2, L3
2	Understand the concepts and apply the methods in basic trees.	L1, L2
3	Use and identify the methods in advanced trees.	L3, L4
4	Understand the concepts and apply the methods in graphs.	L2, L3
5	Understand the concepts and apply the techniques of searching, hashing and sorting	L2, L3
6	Illustrate and examine the methods of linked lists, stacks, queues, trees and graphs to various real time problems	L3, L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement: PC i3 processor and above	**Software requirement:** Turbo/Borland C complier

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction of C programming language.	**02**	----
I	Stacks, Queues and Linked Lists	• Array Implementation of Stack and Queue. • Insertion, deletion operations with Singly linked lists • Insertion, deletion operations Doubly linked lists • Insertion, deletion operations Circular linked lists. • Reversing a singly linked list. • *** Linked List implementation of Stack and Queue**	**04**	LO 1
II	Trees	• *** Implementation of operations (insertion, deletion, counting of nodes, counting of leaf nodes etc.) in a binary search tree.** • Implementation of insertion, deletion and traversal for fully in-threaded binary search tree.	**04**	LO 2
III	Advanced Trees	• *** Implementation of AVL tree.** • Implementation of operations in a B tree.	**04**	LO 3
IV	Graphs	• Implementation of adjacency matrix creation. • Implementation of addition and deletion of edges in a directed graph using adjacency matrix. • Implementation of insertion and deletion of vertices and edges in a directed graph using adjacency list. •	**04**	LO 4
V	Searching and Sorting	• Implementation of Heap Sort • Implementation of Binary Search. • Implementation of Selection sort, Bubble sort, Insertion sort, Quick sort	**04**	LO 5

VI	Applications of Data Structures	- *** Implementation of infix to postfix conversion and evaluation of postfix expression** - *** Implementation of Josephus Problem using circular linked list** - *** Implementation of traversal of a directed graph through BFS and DFS.** - Implementation of finding shortest distances using Dijkstra's algorithm - ***Implementation of hashing functions with different collision resolution techniques**	**04**	LO 6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL302	SQL Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL302	SQL Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To identify and define problem statements for real life applications
2	To construct conceptual data model for real life applications
3	To Build Relational Model from ER/EER and demonstrate usage of relational algebra.
4	To Apply SQL to store and retrieve data efficiently
5	To implement database connectivity using JDBC
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define problem statement and Construct the conceptual model for real life application.	L1, L3, L4, L6
2	Create and populate a RDBMS using SQL.	L3, L4
3	Formulate and write SQL queries for efficient information retrieval	L3, L4
4	Apply view, triggers and procedures to demonstrate specific event handling.	L1, L3, L4
5	Demonstrate database connectivity using JDBC.	L3
6	Demonstrate the concept of concurrent transactions.	L3, L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Any SQL Compiler, Java Programming Language

DETAILED SYLLABUS:

Sr. No.	Detailed Content	Hours	LO Mapping
1.	Identify real world problem and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.	**02**	LO1
2.	Mapping ER/EER to Relational schema model.	**02**	LO1
3.	Create a database using DDL and apply integrity constraints.	**02**	LO2, LO3
4.	Perform data manipulations operations on populated database.	**02**	LO3
5.	Perform Authorization using Grant and Revoke.	**02**	LO2, LO3
6.	Implement Basic and complex SQL queries.	**02**	LO3, LO4
7.	Implementation of Views and Triggers.	**02**	LO4
8.	Demonstrate database connectivity using JDBC.	**02**	LO5
9.	Execute TCL commands.	**02**	LO4
10.	Implement functions and procedures in SQL	**02**	LO3, LO4
11.	Implementation of Cursor.	**02**	LO3, LO4
12.	Implementation and demonstration of Transaction and Concurrency control techniques using locks.	**02**	LO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ― Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Term Work:

Term Work shall consist of at least 10 Practical's based on the above list, but not limited to. Also, Term work Journal must include at least 2 assignments:

> The first assignment may be based on: Relational Algebra and Second may be based on Transactions

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL303	Computer programming Paradigms Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL303	Computer programming Paradigms Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Understand data abstraction and object orientation
2	Design and implement declarative programs in functional and logic programming languages
3	Introduce the concepts of concurrent program execution
4	Understand run time program management
5	Understand how to implement a programming solution using different programming paradigms.
6	Learn to compare implementation in different programming paradigms.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Implement Object Oriented concepts in C++.	L1, L2, L3
2	Design and Develop solution based on declarative programming paradigm using functional and logic programming.	L6
3	Understand the multi threaded programs in Java and C++	L1, L2
4	Understand the need and use of exception handling and garbage collection in C++ and JAVA	L2, L3
5	Implement a solution to the same problem using multiple paradigms.	L6
6	Compare the implementations in multiple paradigms at coding and	L4

	execution level.	

Prerequisite: Students must have learned C Programming (FEC205 and FEL204)

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	C++ compiler, Java Languge support, SWI Prolog, GHC Compiler.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	Demonstrate Compilation and interpretation stages to students for C, C++, JAVA along with how to debug the code.	**02**	**--**
I	Imperative Paradigm: Data Abstraction in Object Orientation	At least two Programming Implementations Preferably in C++ to demonstrate concepts like - Encapsulation, Inheritance, Initialization and Finalization, Dynamic Binding.	**05**	LO1
II	Declarative Programming Paradigm: Functional Programming	• Tutorial Introduction to Haskell programming environment • Tutorial exercise on operators, types etc. in Haskell • At least 5 Haskell Programs to demonstrate Functional Programming Concepts. • Sample Programs but not limited to: ◦ Implement safetail function that behaves in the same way as tail, except that safetail maps the empty list to the empty list, whereas tail gives an error in this case. Define safetail using: (a) a conditional expression; (b) guarded equations; (c) pattern matching. Hint: the library function null :: [a]-> Bool can be used to test if a list is empty. ◦ Simple List Comprehension ◦ Higher-Order Functions ◦ Write recursive function to multiply two natural numbers that uses pre defined add funion. ◦ Implement the game of nim in Haskell to apply list processing. ◦ Haskell code to represent infinite list e.g. fibobacci series ◦ Implement simple Calculator Students should clearly understand the syntax and the execution of the Functional Implementation using Haskell.	**06**	LO2

III	Declarative Programming Paradigm: Logic Programming	- Tutorial Installation and working of SWI Prolog Environment - Implement at least 5 Prolog programs to understand declarative programming concepts. Students should clearly understand the syntax and the execution of the Prolog code Implementation.	**05**	LO2
IV	Alternative Paradigms: Concurrency	At least two Programs preferably in c++ and java to demonstrate Thread management and synchronization	**02**	LO4
V	Run Time Program Management	A Program to understand Exception handling and Garbage collection, preferably in C++ and JAVA Students should understand the syntactic differences in the solutions in both Object Oriented Languages.	**02**	LO4
VI	Programming Assignment For comparative study of Different Paradigms	At Least two implementations each implemented on multiple paradigms like procedural, object oriented, functional, logic. The implementations should be done in a group of two/three students with appropriate difficulty level. Student should prepare small report and present the solution code and demonstrate execution for alternative solutions they build.	**04**	LO5, LO6

Text Books:

1. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
2. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition)
3. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016
4.

References:

1. Sethi R, Programming Languages Concepts and Constructs , 2nd Ed, Pearson Education
2. Yogesh Sajanikar, Haskell Cookbook, Packt Publishing, 2017

Online References:

Sr No	Website Description	Link
1	University Stuttgart Germany Lab Course on Programming Paradigms	http://software-lab.org/teaching/winter2019/pp/
2	Course at MIT Structure and Interpretation of Computer Programs [2019]	https://web.mit.edu/u/6.037
3	Edx Course Paradigms of Computer Programming – Fundamentals,	https://www.edx.org/course/paradigms-of-computer-programming-fundamentals
4	Tutorials point link for Haskel	https://www.tutorialspoint.com/haskell

Term Work: Term Work shall consist of at least 15 Practicals based on the above modules, but not limited to. Also, Term work Journal must include at least 3 tutorial reports and 01 report of programming assignment as mentioned in module VI.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiments/Tutorials) + 5 Marks (Assignment write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & 1 Hr Practical exam will be held based on the above syllabus

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL304	Java Lab (SBL)	--	04	--	--	02	--	02

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL304	Java Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To understand the concepts of object-oriented paradigm in the Java programming language.
2	To understand the importance of Classes & objects along with constructors, Arrays ,Strings and vectors
3	To learn the principles of inheritance, interface and packages and demonstrate the concept of reusability for faster development.
4	To recognize usage of Exception Handling, Multithreading, Input Output streams in various applications
5	To learn designing, implementing, testing, and debugging graphical user interfaces in Java using Swings and AWT components that can react to different user events.
6	To develop graphical user interfaces using JavaFX controls.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamental concepts of Java Programing.	L1, L2
2	Use the concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.	L3
3	Demonstrate how to extend java classes and achieve reusability using Inheritance, Interface and Packages.	L3
4	Construct robust and faster programmed solutions to problems using concept of Multithreading, exceptions and file handling	L3
5	Design and develop Graphical User Interface using Abstract Window Toolkit and Swings along with response to the events.	L6
6	Develop Graphical User Interface by exploring JavaFX framework based on MVC architecture.	L6

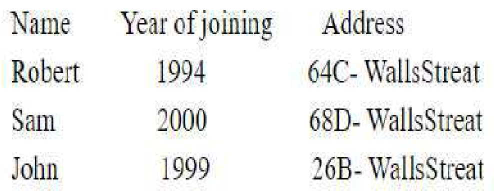
Prerequisite: Basics of Computer Programming

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 2 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. JDK 1.8 or higher 3. Notepad ++ 4.JAVA IDEs like Netbeans or Eclipse	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basics of Computer Programming.	**02**	-
I	Java Fundamentals	**Overview of procedure and object oriented Programming**, Java Designing Goals and Features of Java Language. **Introduction to the principles of object-oriented programming**: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism. Keywords, Data types, Variables, Operators, Expressions, Types of variables and methods. **Control Statements**: If Statement, If-else, Nested if, switch Statement, break, continue. **Iteration Statements:** for loop, while loop, and do-while loop (Perform any 2 programs that covers Classes, Methods, Control structures and Looping statements) 1) Implement a java program to calculate gross salary & net salary taking the following data. Input: empno, empname, basic Process: DA=70% of basic HRA=30% of basic CCA=Rs240/- PF=10% of basic PT= Rs100/- 2) Five Bikers Compete in a race such that they drive at a constant speed which may or may not be the same as the other. To qualify the race, the speed of a racer must be more than the average speed of all 5 racers. Write a Java program to take as input the speed of each racer and print back the speed of qualifying racers. 3) Write a Java program that prints all real solutions to the quadratic equation $ax^2+bx+c = 0$. Read in a, b, c and use the quadratic formula. If the discriminate b^2-4ac is negative, display a message stating that there are no real solutions? 4) Write a Menu driven program in java to implement simple banking application. Application should read	**07**	LO1

		the customer name, account number, initial balance, rate of interest, contact number and address field etc. Application should have following methods. 1. createAccount() 2. deposit() 3. withdraw() 4. computeInterest() 5. displayBalance() 5)Write a menu driven Java program which will read a number and should implement the following methods 1. factorial() 2. testArmstrong() 3. testPalindrome() 4. testPrime() 5. fibonacciSeries() 6) Create a Java based application to perform various ways of Method overloading.		
II	Classes, objects, Arrays and Strings	**Classes & Objects**: Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Static members, Non-Static members Nested and Inner Classes. Static Initialization Block(SIB), Instance Initialization Block(IIB) **Constructors**: Parameterized Constructors, chaining of constructor, finalize() Method, Method overloading, Constructors Overloading. Recursion, Command-Line Arguments. Wrapper classes, InputBufferReader, OutputBufferReader, String Buffer classes, String functions. **Arrays & Vectors**: One and Two Dimensional arrays, Irregular arrays, dynamic arrays, Array List and Array of Object. (Perform any 3 programs that covers Classes & objects, Constructors, Command Line Arguments, Arrays/Vectors,String function and recursions). **Experiments:** 1) Write a program that would print the information (name, year of joining, salary, address) of three employees by creating a class named 'Employee'. The output should be as follows:  Name Year of joining Address Robert 1994 64C- WallsStreat Sam 2000 68D- WallsStreat John 1999 26B- WallsStreat 2) Write a program to print the area of a rectangle by creating a class named 'Area' having two methods. First method named as 'setDim' takes length and breadth of rectangle as parameters and the second method named as 'getArea' returns the area of the rectangle. Length and breadth of rectangle are entered through keyboard. 3) Write a Java program to illustrate Constructor Chaining.	**07**	LO1 LO2

		4) Create a class 'Student' with three data members which are name, age and address. The constructor of the class assigns default values name as "unknown", age as '0' and address as "not available". It has two members with the same name 'setInfo'. First method has two parameters for name and age and assigns the same whereas the second method takes has three parameters which are assigned to name, age and address respectively. Print the name, age and address of 10 students. Hint - Use array of objects. 5) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. 6) Print the sum, difference and product of two complex numbers by creating a class named 'Complex' with separate methods for each operation whose real and imaginary parts are entered by user. 7)Write menu driven program to implement recursive Functions for following tasks. a) To find GCD and LCM b) To print n Fibonacci numbers c) To find reverse of number d) To solve 1 +2+3+4+........+(n- l)+n 8) Print Reverse Array list in java by writing our own function.		
III	Inheritance, Packages and Interfaces.	**Inheritance**: Inheritance Basics, Types of Inheritance in Java, member access, using Super- to call superclass Constructor, to access member of super class(variables and methods), creating multilevel hierarchy, Constructors in inheritance, method overriding, Abstract classes and methods, using final, Dynamic Method Dispatch **Packages**: Defining packages, creating packages and Importing and accessing packages **Interfaces**: Defining, implementing and extending interfaces, variables in interfaces, Default Method in Interface ,Static Method in interface, Abstract Classes vs Interfaces. (Perform any 3 programs covering Inheritance, Interfaces and Packages). **Experiments** 1) Create a Teacher class and derive Professor/ Associate_Professor/Assistant_Professor class from Teacher class. Define appropriate constructor for all the classes. Also define a method to display information of Teacher. Make necessary assumptions as required. 2) Create a class Book and define a display method to display book information. Inherit Reference_Book and Magazine classes from Book class and override display method of Book class in Reference_Book and Magazine classes. Make necessary assumptions required.	**10**	LO1 LO3

3) A university has two types of students — graduate students and research students. The University maintains the record of name, age and programme of every student. For graduate students, additional information like percentage of marks and stream, like science, commerce, etc. is recorded; whereas for research students, additionally, specialization and years of working experience, if any, is recorded. Each class has a constructor. The constructor of subclasses makes a call to constructor of the superclass. Assume that every constructor has the same number of parameters as the number of instance variables. In addition, every subclass has a method that may update the instance variable values of that subclass. All the classes have a function display_student_info( ), the subclasses must override this method of the base class. Every student is either a graduate student or a research student.
Perform the following tasks for the description given above using Java :

(i) Create the three classes with proper instance variables and methods, with suitable inheritance.
(ii) Create at least one parameterised constructor for each class.
(iii) Implement the display_student_info( ) method in each class.

4) An employee works in a particular department of an organization. Every employee has an employee number, name and draws a particular salary. Every department has a name and a head of department. The head of department is an employee. Every year a new head of department takes over. Also, every year an employee is given an annual salary enhancement. Identify and design the classes for the above description with suitable instance variables and methods. The classes should be such that they implement information hiding. You must give logic in support of your design. Also create two objects of each class.

5) Consider a hierarchy, where a sportsperson can either be an athlete or a hockey player. Every sportsperson has a unique name. An athlete is characterized by the event in which he/she participates; whereas a hockey player is characterised by the number of goals scored by him/her.
Perform the following tasks using Java :

(i)Create the class hierarchy with suitable instance variables and methods.
(ii) Create a suitable constructor for each class.
(iii) Create a method named display_all_info with suitable parameters. This method should display all the information about the object of a class.
(iv) Write the main method that demonstrates polymorphism.

6) Create an interface vehicle and classes like bicycle,

		car, bike etc, having common functionalities and put all the common functionalities in the interface. Classes like Bicycle, Bike, car etc implement all these functionalities in their own class in their own way 7) Create a class "Amount In Words" within a user defined package to convert the amount into words. (Consider amount not to be more than 100000).		
IV	Exception Handling, Multithreading, Input Output streams	**Exception Handling:** Exception-Handling Fundamentals, Exception Types, Exception class Hierarchy, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally , Java's Built-in Exceptions, Creating Your Own Exception Subclasses **Multithreaded Programming:** The Java Thread Model and Thread Life Cycle, Thread Priorities, Creating a Thread, Implementing Runnable, Extending Thread, Creating Multiple Threads, Synchronization: Using Synchronized Methods, The synchronized Statement **I/O Streams:** Streams, Byte Streams and Character, The Predefined Streams, Reading Console Input, Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files. (Perform any 3 programs that cover Exception Handling, Multithreading and I/O Streams). **Experiments:** 1) Write java program where user will enter loginid and password as input. The password should be 8 digit containing one digit and one special symbol. If user enter valid password satisfying above criteria then show "Login Successful Message". If user enter invalid Password then create InvalidPasswordException stating Please enter valid password of length 8 containing one digit and one Special Symbol. 2) Java Program to Create Account with 1000 Rs Minimum Balance, Deposit Amount, Withdraw Amount and Also Throws LessBalanceException. It has a Class Called LessBalanceException Which returns the Statement that Says WithDraw Amount(_Rs) is Not Valid. It has a Class Which Creates 2 Accounts, Both Account Deposite Money and One Account Tries to WithDraw more Money Which Generates a LessBalanceException Take Appropriate Action for the Same. 3) Create two threads such that one thread will print even number and another will print odd number in an ordered fashion. 4) Assume that two brothers, Joe and John, share a common bank account. They both can, independently, read the balance, make a deposit, and withdraw some	**10**	LO1 LO3 LO4

		money. Implement java application demonstrate how the transaction in a bank can be carried out concurrently. 5) You have been given the list of the names of the files in a directory. You have to select Java files from them. A file is a Java file if it's name ends with ".java". For e.g. File- "Names.java" is a Java file, "FileNames.java.pdf" is not. **Input:** test.java, ABC.doc, Demo.pdf, add.java, factorial.java, sum.txt **Output:** tset.java, add.java, factorial.java		
V	GUI programming- I (AWT, Event Handling, Swing)	**Designing Graphical User Interfaces in Java**: Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features **Event-Driven Programming in Java**: Event-Handling Process, Event-Handling Mechanism, Delegation Modelof Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling. **Introducing Swing:** AWT vs Swings, Components and Containers, Swing Packages, A Simple Swing Application, Painting in Swing, Designing Swing GUI Application using Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, TablesScroll pane Menus and Toolbar (Perform any 3 programs that contain AWT, Event handling and Swing to build GUI application). 1)Write a Java program to implement Swing components namely Buttons, ,JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, Tables Scroll pane Menus and Toolbars to design interactive GUI. 2) Write a program to create a window with four text fields for the name, street, city and pincode with suitable labels. Also windows contains a button MyInfo. When the user types the name, his street, city and pincode and then clicks the button, the types details must appear in Arial Font with Size 32, Italics. 3) Write a Java program to create a simple calculator using java AWT elements. .Use a grid layout to arrange buttons for the digits and basic operation +, -, /, *. Add a text felid to display the results. 4) Write a Java Program to create a Student Profile form using AWT controls. 5) Write a Java Program to simulate traffic signal light using AWT and Swing Components.	**12**	LO1 LO4 LO5

		6) Write a Java Program to create a color palette. Declare a grid of Buttons to set the color names. Change the background color by clicking on the color button. 7) Build a GUI program that allows the user to add objects to a collection and perform search and sort on that collection.(Hint. Use Swing components like JButton, JList, JFrame, JPanel and JOptionPane.)		
VI	GUI Programming-II (JavaFX)	JavaFX Basic Concepts, JavaFX application skeleton, Compiling and running JavaFX program,Simple JavaFX control:Label,Using Buttons and events, Drawing directly on Canvas. (Perform any one program that contains the concept of JavaFX). 1)Write a Java program to design a Login Form using JavaFX Controls. 2)Write Java program to draw various shapes on Canvas using JavaFX.	**04**	LO1 LO5 LO6

Text Books:

1. Herbert Schildt, "Java-The Complete Reference", Tenth Edition, Oracle Press, Tata McGraw Hill Education.
2. E. Balguruswamy, "Programming with Java A primer", Fifth edition, Tata McGraw Hill Publication
3. Anita Seth, B.L.Juneja, " Java One Step Ahead", oxford university press.

References:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press.
2. Learn to Master Java by Star EDU Solutions
3. Yashvant Kanetkar, "Let Us Java" ,4th Edition ,BPB Publications.

Term Work:

The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	04	--	--	02	--	02

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Second Year Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC401	Engineering Mathematics-IV	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC401	Engineering Mathematics-IV	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To study Matrix algebra and its application in engineering problems.
2	To learn Line and Contour integrals and expansion of complex valued function in a power series.
3	To study Z-Transforms and Inverse Z-Transforms with its properties.
4	To acquaint with the concepts of probability distributions and sampling theory for small samples.
5	To study and apply Linear and Non-linear programming Techniques to solve the optimization problems

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply the concepts of eigen values and eigen vectors to solve engineering problems.	L1, L2, L3
2	Illustrate the use of concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.	L3
3	Apply the concept of Z- transformation and its inverse in engineering problems.	L1,L2,L3

4	Apply the concept of probability distribution to engineering problems & testing hypothesis of small samples using sampling theory.	L3
5	Apply the concept of Linear Programming to solve the optimization problems	L1, L2, L3
6	Use the Non-Linear Programming techniques to solve the optimization problems.	L3

Module	Detailed Contents	Hours	CO Mapping
01	**Module: Linear Algebra (Theory of Matrices)** 1.1 Characteristic Equation, Eigenvalues and Eigenvectors and properties (without proof) 1.2 Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials 1.3 Similarity of matrices, diagonalizable and non-diagonalizable matrices **Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	7	CO1
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	7	CO2
03	**Module: Z Transform** 3.1 Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}$, $\{a^{\lvert k \rvert}\}$, $\{{}^{k+n}_{\;\;n}C . a^k\}$, $\{c^k \sin(\alpha k + \beta)\}$, $\{c^k \sinh \alpha k\}$, $\{c^k \cosh \alpha k\}$. 3.2 Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem. 3.3 Inverse Z transform: Partial Fraction Method, Convolution Method. **Self-learning Topics:** Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	5	CO3
04	**Module: Probability Distribution and Sampling Theory** 4.1 Probability Distribution: Poisson and Normal distribution 4.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 4.3 Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table. **Self-learning Topics:** Test significance for Large samples, Estimate parameters of a population., Yate's Correction.	7	CO4
05	**Module: Linear Programming Problems**	6	

	5.1 Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method. 5.2 Artificial variables, Big-M method (Method of penalty) 5.3 Duality, Dual of LPP and Dual Simplex Method **Self-learning Topics: Sensitivity** Analysis, Two-Phase Simplex Method, Revised Simplex Method		CO5
06	**Module: Nonlinear Programming Problems** 6.1 NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers 6.2 NLPP with two equality constraints 6.3 NLPP with inequality constraint: Kuhn-Tucker conditions **Self-learning Topics:** Problems with two inequality constraints, Unconstrained optimization: One dimensional search method (Golden Search method, Newton's method). Gradient Search method	7	CO6

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
3. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
5. Operations Research: An Introduction, Hamdy A Taha, Pearson.
6. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell.
7. Operations Research, Hira and Gupta, S. Chand Publication.

Online References:

Sr. No.	**Website Name**
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC402	Computer Network and Network Design	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC402	Computer Network and Network Design	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	Understand the division of network functionalities into layers.
2	Understand the types of transmission media along with data link layer concepts, design issues and protocols
3	Analyze the strength and weaknesses of routing protocols and gain knowledge about IP addressing
4	Understand the data transportation, issues and related protocols for end to end delivery of data.
5	Understand the data presentation techniques used in presentation layer & client/server model in application layer protocols.
6	Design a network for an organization using networking concepts

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Describe the functionalities of each layer of the models and compare the Models.	L1
2	Categorize the types of transmission media and explain data link layer concepts, design issues and protocols.	L2, L3, L4
3	Analyze the routing protocols and assign IP address to networks.	L4
4	Explain the data transportation and session management issues and related protocols used for end to end delivery of data.	L1, L2
5	List the data presentation techniques and illustrate the client/server model in application layer protocols.	L1, L3
6	Use of networking concepts of IP address, Routing, and application services to design a network for an organization	L3

Prerequisite: PCOM

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Terminologies of communication	**02**	-
I	**Introduction to Computer Networks**	Uses Of Computer Networks, Network Hardware, Network Software, Protocol Layering, Reference Models: OSI, TCP/IP, Comparison of OSI & TCP/IP, Network Devices. **Self-learning Topics:** Identify the different devices used in Network connection. College campus	**03**	CO1
II	**Physical Layer & Data Link Layer**	**Physical layer:** Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching, Structure Of A Switch **DLL Design Issues** (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code,Parity, CRC, Checksum) , Elementary Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking, HDLC **Medium Access Protocols:** Random Access, Controlled Access, Channelization. Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet. **Self-learning Topics:** Differentiate link layer in IOT network and Normal Network.	**08**	CO2
III	**Network Layer**	Network Layer Services, Packet Switching, Network Layer Performance, IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT). **Routing algorithms**: Distance Vector Routing, Link state routing,Path Vector Routing. **Protocols** –RIP,OSPF,BGP. **Next Generation IP:** IPv6 Addressing,IPv6 Protocol, Transition fromIPV4 to IPV6 **Self-learning Topics:** Study difference between IPV4 and IPV6. Network Class A, B, C, D, E and subnet mask.	**08**	CO3

IV	**Transport Layer & Session Layer**	**Transport Layer:** Transport Layer Services, Connectionless & Connection-oriented Protocols, Transport Layer protocols: User Datagram Protocol: UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers. **Session Layer:** Session layer design issues, Session Layer protocol - Remote Procedure Call (RPC), **Self-learning Topics:** List real time example of UDP and TCP.	**07**	CO4
V	**Presentation Layer & Application Layer**	**Presentation layer** :Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, Speech Compression, LZW, RLE, Image Compression – GIF,JPEG. **Application layer:** Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP **Self-learning Topics:** Difference between HTTP and FTP Protocol.	**05**	CO5
VI	**Network Design Concepts**	Introduction to VLAN ,VPN A case study to design a network for an organization meeting the following guidelines: Networking Devices, IP addressing: Subnetting, Supernetting, Routing Protocols to be used, Services to be used: TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server. **Self-learning Topics:** Study the Network Design of your college campus.	**06**	CO6

Text Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.
2. Behrouz A. Forouzan, Data Communications and Networking ,4th Edition,Mc Graw Hill education.

References:

1. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, “TCP/IP Protocol Suite”, Tata McGraw Hill edition, Third Edition.
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGrawHill , Second Edition.
4. Khalid Sayood, Introduction to Data Compression, Third Edition, Morgan Kaufman.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC403	Operating System	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC403	Operating System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To understand the major components of Operating System &its functions.
2	To introduce the concept of a process and its management like transition, scheduling, etc.
3	To understand basic concepts related to Inter-process Communication (IPC) like mutual exclusion, deadlock, etc. and role of an Operating System in IPC.
4	To understand the concepts and implementation of memory management policies and virtual memory.
5	To understand functions of Operating System for storage management and device management.
6	To study the need and fundamentalsof special-purpose operating system with the advent of new emerging technologies.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to Operating System.	L1, L2
2	Describe the process management policies and illustrate scheduling of processes by CPU.	L1
3	Explain and apply synchronization primitives and evaluate deadlock conditionsas handled by Operating System.	L2
4	Describe and analyze the memory allocation and management functions of Operating System.	L1
5	Analyze and evaluate the services provided by Operating System for storage management.	L4, L5
6	Compare the functions of various special-purpose Operating Systems.	L2

Prerequisite: Programming Language C

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Programming Language C; Basic of Hardware i.e. ALU, RAM, ROM, HDD, etc.; Computer-System Organization.	**02**	-
I	Fundamentals of Operating System	Introduction to Operating Systems; Operating System Structure and Operations; Functions of Operating Systems; Operating System Services and Interface; System Calls and its Types; System Programs; Operating System Structure; System Boot. **Self-learning Topics:** Study of any three different OS. System calls with examples for different OS.	**03**	CO1
II	Process Management	Basic Concepts of Process; Operation on Process; Process State Model and Transition; Process Control Block; Context Switching; Introduction to Threads; Types of Threads, Thread Models; Basic Concepts of Scheduling; Types of Schedulers; Scheduling Criteria; Scheduling Algorithms. **Self-learning Topics:** Performance comparison of Scheduling Algorithms, Selection of Scheduling Algorithms for different situations, Real-time Scheduling	**06**	CO2
III	ProcessCoordination	Basic Concepts of Inter-process Communication and Synchronization; Race Condition; Critical Region and Problem; Peterson’s Solution; Synchronization Hardware and Semaphores; Classic Problems of Synchronization; Message Passing; Introduction to Deadlocks; System Model, Deadlock Characterization; Deadlock Detection and Recovery; Deadlock Prevention; Deadlock Avoidance. **Self-learning Topics:** Study a real time case study for Deadlock detection and recovery.	**09**	CO3
IV	Memory Management	Basic Concepts of Memory Management; Swapping; Contiguous Memory Allocation; Paging; Structure of Page Table; Segmentation; Basic Concepts of Virtual Memory; Demand Paging, Copy-on Write; Page Replacement Algorithms; Thrashing. **Self-learning Topics:** Memory Management for any one Operating System, Implementation of Page Replacement Algorithms.	**09**	CO4

V	Storage Management	Basic Concepts of File System; File Access Methods; Directory Structure; File-System Implementation; Allocation Methods; Free Space Management; Overview of Mass-Storage Structure; Disk Structure; Disk Scheduling; RAID Structure; Introduction to I/O Systems. **Self-learning Topics:** File System for Linux and Windows, Features of I/O facility for different OS.	**06**	CO5
VI	Special-purpose Operating Systems	Open-source and Proprietary Operating System; Fundamentals of Distributed Operating System; Network Operating System;Embedded Operating Systems;Cloud and IoT Operating Systems; Real-Time Operating System;Mobile Operating System; Multimedia Operating System;Comparison between Functions of various Special-purpose Operating Systems. **Self-learning Topics:** Case Study on any one Special-purpose Operating Systems.	**04**	CO6

Text Books:

1. A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, 10th ed., Wiley, 2018.
2. W. Stallings, Operating Systems: Internal and Design Principles, 9th ed., Pearson, 2018.
3. A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.

Reference Books:

1. N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014.
2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd ed., Pearson.
3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018.

Online References:

Sr. No.	**Website Name**
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC404	Automata Theory	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC404	Automata Theory	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn fundamentals of Regular and Context Free Grammars and Languages.
2	To understand the relation between Regular Language and Finite Automata and machines.
3	To learn how to design Automata's as Acceptors, Verifiers and Translators.
4	To understand the relation between Regular Languages, Contexts free Languages, PDA and TM.
5	To learn how to design PDA as acceptor and TM as Calculators.
6	To learn applications of Automata Theory.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain, analyze and design Regular languages, Expression and Grammars.	L2, L4, L6
2	Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.	L6
3	Analyze and design Context Free languages and Grammars.	L4, L6
4	Design different types of Push down Automata as Simple Parser.	L6
5	Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine.	L6
6	Develop understanding of applications of various Automata.	L6

Prerequisite: Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.	**02**	-
I	Introduction and Regular Languages	Languages: Alphabets and Strings. Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL grammars, Closure properties **Self-learning Topics:** Practice exercise on Regular Expressions. Identify the tools also.	**05**	CO1
II	Finite Automata	Finite Automata: FA as language acceptor or verifier, NFA (with and without ε) , DFA, RE to NFA, NFA to DFA, Reduced DFA , NFA-DFA equivalence, FA to RE. Finite State Machines with output : Moore and Mealy machines. Moore and Mealy M/C conversion. Limitations of FA. **Self-learning Topics:** Practice exercise on FA and NFA	**09**	CO2
III	Context Free Grammars	Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification and Normalization (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3) **Self-learning Topics:** Practice numerical or exercise on CFG	**08**	CO3
IV	Push Down Automata	Push Down Automata: Deterministic (single stack) PDA, Equivalence between PDA and CFG. Power and Limitations of PDA. **Self-learning Topics:** List the examples of PDA.	**05**	CO4
V	Turing Machine	Turing Machine: Deterministic TM, Variants of TM, Halting problem, Power of TM. **Self-learning Topics:** Practice numerical of TM.	**07**	CO5
VI	Applications of Automata	Applications of FA, CFG, PDA & TM. Introduction to Compiler & Its phases. **Self-learning Topics:** Case study on any one compiler.	**03**	CO2,CO3, CO4,CO5, CO6

Text books

1. J.C.Martin, “Introduction to languages and the Theory of Computation”, TMH.
2. Kavi Mahesh, “Theory of Computation A Problem Solving Approach”, Wiley India
3. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman , “Compilers Principles, Techniques and Tools “,Pearson Education.

References

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education.
2. Daniel I.A. Cohen, “Introduction to Computer Theory”, John Wiley & Sons.
3. Vivek Kulkarni,” Theory of Computation”, Oxford University.
4. N.Chandrashekhar, K.L.P. Mishra, “Theory of Computer Science, Automata Languages & Computations”, PHI publications.
5.J. J. Donovan, “ Systems Programming”, TMH.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://online.stanford.edu
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

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Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC405	Computer Organization and Architecture	03	--	--	03	--	--	03

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC405	Computer Organization and Architecture	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	Learn the fundamentals of Digital Logic Design.
2	Conceptualize the basics of organizational and features of a digital computer.
3	Study microprocessor architecture and assembly language programming.
4	Study processor organization and parameters influencing performance of a processor.
5	Analyse various algorithms used for arithmetic operations.
6	Study the function of each element of memory hierarchy and various data transfer techniques used in digital computer.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Demonstrate the fundamentals of Digital Logic Design	L1, L2
2	Describe basic organization of computer, the architecture of 8086 microprocessor and implement assembly language programming for 8086 microprocessors.	L1
3	Demonstrate control unit operations and conceptualize instruction level parallelism.	L1, L2
4	List and Identify integers and real numbers and perform computer arithmetic operations on integers.	L1,L4
5	Categorize memory organization and explain the function of each element of a memory hierarchy.	L4
6	Examine different methods for computer I/O mechanism.	L3

Prerequisite: Basics of Electrical Engineering, Fundamentals of Computer.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basics of Electrical Engineering, Fundamentals of Computer	**02**	
I	**Fundamentals of Logic Design**	Number systems: Introduction to Number systems, Binary Number systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal number and their conversions, 1's and 2's complement Combinational Circuits: NOT,AND,OR,NAND,NOR,EX-OR,EX-NOR Gates. Half & Full Adder and subtractor, Reduction of Boolean functions using K-map method (2,3,4 Variable), introduction to Multiplexers and Demultiplexers, Encoders & Decoders. Sequential Circuits: Introduction to Flip Flops: SR, JK, D, T, master slave flip flop, Truth Table. **Self-learning Topics:** Number System, Quine-McCluskey,Flip-Flop conversion, Counter Design.	**07**	CO1
II	**Overview of Computer Architecture & Organization**	Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture, Amdahl's Law Architecture of 8086 Family, Instruction Set, Addressing Modes, Assembler Directives, Mixed-Language Programming, Stack, Procedure, Macro. **Self-learning Topics:** Interfacing of I/O devices with 8086(8255,ADC,DAC).	**08**	CO2
III	**Processor Organization and Architecture**	CPU Architecture, Instruction formats, basic instruction cycle with Interrupt processing. Instruction interpretation and sequencing. Control Unit: Soft wired (Microprogrammed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations, concepts of nano programming. Introduction to parallel processing concepts, Flynn's classifications, instruction pipelining, pipeline hazards. **Self-learning Topics**: Study the examples on instruction pipelining for practice.	**07**	CO3
IV	**Data Representation and Arithmetic Algorithms**	Booth's algorithm. Division of integers: Restoring and non-restoring division, signed division, basics of floating-point representation IEEE 754 floating point (Single & double precision) number representation. **Self-learning Topics:** Implement Booth's Algorithm and Division methods.	**04**	CO4
V	**Memory Organization**	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics. Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory	**07**	CO5

		Self-learning Topics: Case study on Memory Organization, Numerical on finding EAT, Address mapping.		
VI	**I/O Organization**	Input/output systems, I/O module-need & functions and Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA **Self-learning Topics:** Comparison of all I/O methods.	**04**	CO6

Text Books:

1. R. P. Jain,"Modern Digital Electronics", TMH
2. M. Morris Mano,"Digital Logic and Computer Design", PHI
3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, Fifth Edition, Tata McGraw-Hill.
4. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition,, Pearson
5. John Uffenbeck, 8086/8088 family: Design Programming and Interfacing, (Pearson Education

References:

1. A. Anand Kumar, "Fundamentals of Digital Circuits",. PHI
2. Donald P Leach, Albert Paul Malvino, "Digital Principals & Applications", TMH.
3. B. Govindarajulu,, Computer Architecture and Organization: Design Principles and Applications, Computer Architecture and Organization: Design Principles and Applications, Tata McGraw-Hill
4. Dr. M. Usha, T. S. Srikanth, Computer System Architecture and Organization, First Edition, Wiley-India.
5. John P. Hayes, Computer Architecture and Organization, Third Edition., McGraw-Hill
6. K Bhurchandi, Advanced Microprocessors & Peripherals, Tata McGraw-Hill Education

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.geeksforgeeks.org
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL401	Network Lab	--	02	--	--	01	--	01

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL401	Network Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To get familiar with the basic network administration commands
2	To install and configure network simulator and learn basics of TCL scripting.
3	To understand the network simulator environment and visualize a network topology and observe its performance
4	To implement client-server socket programs.
5	To observe and study the traffic flow and the contents of protocol frames.
6	To design and configure a network for an organization

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Execute and evaluate network administration commands and demonstrate their use in different network scenarios	L3, L5
2	Demonstrate the installation and configuration of network simulator.	L1, L2
3	Demonstrate and measure different network scenarios and their performance behavior.	L1, L2
4	Implement the socket programming for client server architecture.	L3
5	Analyze the traffic flow of different protocols	L4
6	Design a network for an organization using a network design tool	L6

Prerequisite: C /Java

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	NS2.34, Protocol Analyzer (eg. Wireshark), C/Java/python

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	**Prerequisite**	Programming Language (C/Java), Basic commands of windows and Unix/Linux operating system. editor commands (eg nano/vi editor etc)	**02**	-
I	**Fundamentals of Computer Network**	Understanding Basic networking Commands: ifconfig ,ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump • Execute and analyze basic networking commands.	**02**	LO1
II	**Basics of Network simulation**	Installation and configuration of NS2. Introduction to Tcl Hello Programming • Installation and configuring of NS-2 simulator and introduction to Tcl using Hello program	**02**	LO2
III	**Simulation of Network Topology with different Protocols**	Implementation of Specific Network topology with respect to 1. Number of nodes and physical layer configuration 2. Graphical simulation ofnetwork with RoutingProtocols(Distance Vector/ Link State Routing) and trafficconsideration (TCP, UDP)using NAM. 3. Analysis of networkperformance for quality ofservice parameters such aspacket-delivery-ratio, delayand throughput 4. Comparative analysis of routing protocols with respect to QOS parametersusing Xgraph/gnuplot fordifferent load conditions. • Write TCL scripts to create topologies. Create and run traffics and analyze the result using NS2 • Write TCL scripts for topology with Graphical simulation of traffic consideration (TCP, UDP) using NAM and plot the graph • Implement distance vector and link state routing protocols in NS2.	**06**	LO3 LO5
IV	**Socket Programming**	Socket Programming with C/Java/python 1. TCP Client, TCP Server 2. UDP Client, UDP Server • To study and Implement Socket Programming using TCP.	**04**	LO4

		- To study and Implement Socket Programming using UDP		
V	**Protocol Analyzer**	1. Study of various Network Protocol Analyzer Tools likeWireshark, tcpdump, Windump, Microsoft Message Analyzer, Ettercap, Nirsoft SmartSniff etc. 2. Install one of the Network protocol analyzer tools and analyze the traffic - Study various network protocol analyzer tools and analyze the network traffics using one of the network protocol analyzer tools.	**04**	LO5
VI	**Network Design**	Network Design for an organization using the following concepts: 1. Addressing (IP Address Assignment), 2. Naming (DNS) 3. Routing - Perform remote login using Telnet Server - Design a network for an organization using the concepts of Addressing (IP Address Assignment), Naming (DNS) and Routing. Also mention the internetworking devices used	**06**	LO6

Text Books:

1. Computer Network Simulation in NS2 Basic Concepts and Protocol Implementation.-Prof Neeraj Bhargava,Pramod Singh Rathore,Dr.Ritu Bhargava,Dr.Abhishek Kumar, First Edition.BPB Publication.
2. Packet analysis with Wire shark, Anish Nath, PACKT publishing
3. TCP/IP Protocol Suite 4th Edition by Behrouz A. Forouzan

References:

1. NS2.34 Manual
2. Practical Packet Analysis: Using Wireshark to Solve Real-World Network Problems by Chris Sanders

Term Work: Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL402	Unix Lab	--	02	--	--	01	--	01

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL402	Unix Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To understand architecture and installation of Unix Operating System
2	To learn Unix general purpose commands and programming in Unix editor environment
3	To understand file system management and user management commands in Unix.
4	To understand process management and memory management commands in Unix
5	To learn basic shell scripting.
6	To learn scripting using awk and perl languages.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the architecture and functioning of Unix	L1, L2
2	Identify the Unix general purpose commands	L4
3	Apply Unix commands for system administrative tasks such as file system management and user management.	L3
4	Execute Unix commands for system administrative tasks such as process management and memory management	L4
5	Implement basic shell scripts for different applications.	L3
6	Implement advanced scripts using awk & perl languages and grep, sed, etc. commandsfor performing various tasks.	L3

Prerequisite: Programming Language C

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Unix, Editor, Bash shell, Bourne shell and C shell

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Programming Skills, Concepts of Operating System	**02**	-
I	Introduction to Unix	Case Study: Brief History of UNIX, Unix Architecture; Installation of Unix Operating System	**03**	LO1
II	Basic Commands	a) Execution of Unix General Purpose Utility Commands like echo, clear, exit, date, time, uptime, cal, cat, tty, man, which, history, id, pwd, whoami, ping, ifconfig, pr, lp, lpr, lpstat, lpq, lprm, cancel, mail, etc. b) Working with Editor Vi/other editor.	**03**	LO2
III	Commands for File System Management and User Management	a) Study of Unix file system (tree structure), file and directory permissions, single and multiuser environment. b) Execution of File System Management Commands like ls, cd, pwd, cat, mkdir, rmdir, rm, cp, mv, chmod, wc, piping and redirection, grep, tr, echo, sort, head, tail, diff, comm, less, more, file, type, wc, split, cmp, tar, find, vim, gzip, bzip2, unzip, locate, etc. c) Execution of User Management Commands like who, whoami, su, sudo, login, logout, exit, passwd, useradd/adduser, usermod, userdel, groupadd, groupmod, groupdel, gpasswd, chown, chage, chgrp, chfn, etc.	**04**	LO3
IV	Commands for Process Management and Memory Management	a) Execution of Process Management Commands like ps, pstree, nice, kill, pkill, killall, xkill, fg, bg, pgrep, renice, etc. b) Execution of Memory Management Commands like free, /proc/meminfo, top, htop, df, du, vmstat, demidecode, sar, pagesize, etc.	**04**	LO4
V	Basic Scripts	a) Study of Shell, Types of Shell, Variables andOperators b) Execute the following Scripts (at least 6): (i) Write a shell script to perform arithmetic operations. (ii) Write a shell script to calculate simple interest. (iii) Write a shell script to determine largest among three integer numbers. (iv) Write a shell script to determine a given year is leap year or not. (v) Write a shell script to print multiplication table of given number using while statement.	**04**	L02, L03, L05

		(vi) Write a shell script to search whether element is present is in the list or not. (vii) Write a shell script to compare two strings. (viii) Write a shell script to read and check if the directory / file exists or not, if not make the directory / file. (ix) Write a shell script to implement menu-driven calculator using case statement. (x) Write a shell script to print following pattern: * * * * * * * * * * (xi) Write a shell script to perform operations on directory like: display name of current directory; display list of directory contents; create another directory, write contents on that and copy it to a suitable location in your home directory; etc.		
VI	Advanced Scripts	a) Execute the following scripts using grep / sed commands: (i) Write a script using grep command to find the number of words character, words and lines in a file. (ii) Write ascriptusing egrep command to display list of specific type of files in the directory. (iii) Write a script using sed command to replace all occurrences of particular word in given a file. (iv) Write a script using sedcommand to print duplicated lines in input. b) Execute the following scripts using awk / perl languages: (i) Write an awk script to print all even numbers in a given range. (ii) Write an awk script to develop a Fibonacci series (take user input for number of terms). (iii) Write a perl script to sort elements of an array. (iv) Write a perl script to check a number is prime or not.	**06**	LO2, L03, L06

Text Books:

1. S. Das, Unix Concepts and Applications, 4th ed., McGraw Hill, 2017.
2. R. Michael, Mastering Unix Shell Scripting, 2nd ed., Wiley, 2008.
3. D. Ambawade, D. Shah, Linux Labs and Open Source Technologies, Dreamtech Press, 2014.

References:

1. Y. Kanetkar, Unix Shell Programming, BPB Publications, 2003.
2. B. Forouzan and R. Gilberg, Unix and Shell Programming, Cengage Learning, 2003.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL403	Microprocessor Lab	--	02	--	--	01	--	01

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL403	Microprocessor Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	Learn assembling and disassembling of PC
2	Design, simulate and implement different digital circuits
3	Get hands on experience with Assembly Language Programming.
4	Study interfacing of peripheral devices with 8086 microprocessor.
5	Realize techniques for faster execution of instructions and improve speed of operation and performance of microprocessors.
6	Write and debug programs in TASM/MASM/hardware kits

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Demonstrate various components and peripheral of computer system	L2
2	Analyze and design combinational circuits	L4, L6
3	Build a program on a microprocessor using arithmetic & logical instruction set of 8086.	L3
4	Develop the assembly level programming using 8086 loop instruction set	L6
5	Write programs based on string and procedure for 8086 microprocessor.	L1
6	Design interfacing of peripheral devices with 8086 microprocessor.	L6

Prerequisite: Logic Design, Programming Languages(C, C++)

Hardware & Software Requirements:

NOTE: Programs can be executed on assembler or hardware boards.

Hardware Requirement:	**Software requirement:**
➢ Motherboard, RAM, Processor, Connectors, Cables, SMPS, HDD, Monitor, Graphics card (optional), and Cabinet. ➢ 8086 microprocessor experiment kits with specified interfacing study boards	➢ Microsoft Macro Assembler (TASM)/Turbo Assembler (TASM) ➢ Virtual simulator lab. ➢ Proteus design suite

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	PC Assembly	Study of PC Motherboard Technology (South Bridge and North Bridge), Internal Components and Connections used in computer system.	**02**	LO1
II	Implementation of combinational circuits	1. Verify the truth table of various logic gates (basic and universal gates) 2. Realize Half adder and Full adder 3. Implementation of MUX and DeMUX	**06**	LO2
III	Arithmetic and logical operations in 8086 Assembly language programming	1. Program for 16 bit BCD addition 2. Program to evaluate given logical expression. 3. Convert two digit Packed BCD to Unpacked BCD. (any two)	**05**	LO3
IV	Loop operations in 8086 Assembly language programming	1. Program to move set of numbers from one memory block to another. 2. Program to count number of 1's and 0's in a given 8 bit number 3. Program to find even and odd numbers from a given list 4. Program to search for a given number (any three)	**06**	LO4
V	String &Procedure in 8086 Assembly language programming	1. Check whether a given string is a palindrome or not. 2. Compute the factorial of a positive integer 'n' using procedure. OR Generate the first 'n' Fibonacci numbers.	**04**	LO5
VI	Interfacing with 8086 microprocessor	1. Interfacing Seven Segment Display 2. Interfacing keyboard matrix 3. Interfacing DAC (any one)	**03**	LO6

Text Books:

1. Scott Mueller, ”Upgrading and repairing PCs”, Pearson,
2. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
3. John Uffenbeck, “8086/8088 family: Design Programming and Interfacing:”Pearson Education

Reference Books:

1. M. Morris Mano, “Digital Logic and computer Design”, PHI
2. K Bhurchandi, “Advanced Microprocessors & Peripherals”, Tata McGraw-Hill Education

Term Work: Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	**Lab Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL404	Python Lab (SBL)	--	04	--	--	02	--	02

Lab Code	**Lab Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL404	Python Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	Basics of python including data types, operator, conditional statements, looping statements, input and output functions in Python
2	List, tuple, set, dictionary, string, array and functions
3	Object Oriented Programming concepts in python
4	Concepts of modules, packages, multithreading and exception handling
5	File handling, GUI & database programming
6	Data visualization using Matplotlib, Data analysis using Pandas and Web programming using Flask

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the structure, syntax, and semantics of the Python language.	L1, L2
2	Interpret advanced data types and functions in python	L1, L2
3	illustrate the concepts of object-oriented programming as used in Python	L2
4	Create Python applications using modules, packages, multithreading and exception handling.	L6
5	Gain proficiency in writing File Handling programs ,also create GUI applications and evaluate database operations in python.	L1, L2
6	Design and Develop cost-effective robust applications using the latest Python trends and technologies	L6

Prerequisite: Structured Programming Approach & Java Programming Lab

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 2 GB RAM 3. Minimum 40 GB Hard disk 4. Network interface card	1. Windows or Linux Desktop OS 2. Python 3.6 or higher 3. Notepad ++ 4.Python IDEs like IDLE, Pycharm, Pydev, Netbeans or Eclipse 5. Mysql	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Python IDE installation and environment setup.	**02**	
I	**Basics of Python**	Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments, Basic data types (Numeric, Boolean, Compound) Operators: Arithmetic, comparison, relational, assignment, logical, bitwise, membership, identity operators, operator precedence Control flow statements: Conditional statements (if, if…else, nested if) Looping in Python (while loop, for loop, nested loops) Loop manipulation using continue, pass, break. Input/output Functions, Decorators, Iterators and Generators.	**08**	LO 1
II	**Advanced data types & Functions**	Lists: a) Defining lists, accessing values in list, deleting values in list, updating lists b) Basic list operations c) Built-in list functions Tuples: a) Accessing values in Tuples, deleting values in Tuples, and updating Tuples b) Basic Tuple operations c) Built-in Tuple functions Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary b) Basic Dictionary operations c) Built-in Dictionary functions Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set operations, c) Built-in Set functions Strings: a) String initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String functions Arrays: a) Working with Single dimensional Arrays: Creating, importing, Indexing, Slicing, copying and processing array arrays. b) Working with Multi-dimensional Arrays using Numpy: Mathematical operations, Matrix operations, aggregate and other Built-in functions	**09**	LO 1 LO 2

		Functions: a) Built-in functions in python b) Defining function, calling function, returning values, passing parameters c) Nested and Recursive functions d) Anonymous Functions (Lambda, Map, Reduce, Filter)		
III	**Object Oriented Programming**	Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python.	**08**	LO 1 LO 3
IV	**Exploring concept of modules, packages, multithreading and exception handling**	Modules: Writing modules, importing objects from modules, Python built-in modules (e.g. Numeric and Mathematical module, Functional Programming module, Regular Expression module), Namespace and Scoping. Packages: creating user defined packages and importing packages. Multi-threading: process vs thread, use of threads, types of threads, creating threads in python, thread synchronization, deadlock of threads. Exception handling: Compile time errors, Runtime errors, exceptions, types of exception, try statement, except block, raise statement, Assert statement, User-Defined Exceptions.	**06**	LO 1 LO 4
V	**File handling, GUI & database programming**	File Handling: Opening file in different modes, closing a file, writing to a file, accessing file contents using standard library functions, reading from a file – read (), readline (), readlines (), Renaming and Deleting a file, File Exceptions, Pickle in Python. Graphical user interface (GUI): different GUI tools in python (Tkinter, PyQt, Kivy etc.), Working with containers, Canvas, Frame, Widgets (Button, Label, Text, Scrollbar, Check button, Radio button, Entry, Spinbox, Message etc.) Connecting GUI with databases to perform CRUD operations. (on supported databases like SQLite, MySQL, Oracle, PostgreSQL etc.).	**09**	LO 1 LO 5
VI	**Data visualization, analysis and web programming using python**	Visualization using Matplotlib: Matplotlib with Numpy, working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.), working with multiple figures. Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python, series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates. SciPy: Linear algebra functions using Numpy and Scipy. Web programming: Introduction to Flask, Creating a Basic Flask Application, Build a Simple REST API using Flask	**10**	LO 1 LO 6

List of Experiments/Mini-Project.

1)	Write python programs to understand a) Basic data types, Operators, expressions and Input Output Statements b) Control flow statements: Conditional statements (if, if…else, nested if) c) Looping in Python (while loop, for loop, nested loops) d) Decorators, Iterators and Generators.
2)	Write python programs to understand a) Different List and Tuple operations using Built-in functions b) Built-in Set and String functions c) Basic Array operations on 1-D and Multidimensional arrays using Numpy d) Implementing User defined and Anonymous Functions
3)	Write python programs to understand a) Classes, Objects, Constructors, Inner class and Static method b) Different types of Inheritance c) Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python.
4)	Write python programs to understand a) Creating User-defined modules/packages and import them in a program b) Creating user defined multithreaded application with thread synchronization and deadlocks c) Creating a menu driven application which should cover all the built-in exceptions in python
5)	Write python programs to understand a) Different File Handling operations in Python b) Designing Graphical user interface (GUI) using built-in tools in python (Tkinter, PyQt, Kivy etc.). c) GUI database connectivity to perform CRUD operations in python (Use any one database like SQLite, MySQL, Oracle, PostgreSQL etc.)
6)	Write python programs to implement a) Different types of plots using Numpy and Matplotlob b) Basic operations using pandas like series, data frames, indexing, filtering, combining and merging data frames. c) Different Linear algebra functions using Scipy. d) A Basic Flask Application to build a Simple REST API.

❖ **Mini Project**

Mini-project have to be developed in a group of three students which should cover all above topics.
Suggested Mini-Project Topics:

1. Railway reservation system	27 IT Team Workspace	52. Business Directory	78. Practice Test Management.
2. Inventory Management system.	29 Job Requisition and Interview Management	53. Education Directory	79. Asset Management System
3 Classroom Management	28 Knowledge Base	54. Dental Clinic Management	80. Travel Agency System.
4 Clinical Trial Initiation and Management	29 Lending Library	55. Fund Raising Management	81. Placement Management System.

5 Competitive Analysis Web Site	30 Physical Asset Tracking and Management	56. Clinic/ Health Management	82. Polls Management
6 Discussion Forum website	31 Project Tracking Workspace	57. Cable Management System	83. Customer Management
7 Disputed Invoice Management	32. Shopping Cart .	58. Survey Creation and Analytics	84. Project Management System.
8 Employee Training Scheduling and Materials	33 Knowledge Base	59. Museum Management System	85. Network Marketing System
9 Equity Research Management	34 Lending Library	60. Multi-Level Marketing System	86. Yoga Health Care Management
10 Integrated Marketing Campaign Tracking	35 Physical Asset Tracking and Management	61. Learning Management System	87. Personal Finance Management System
11 Manufacturing Process Managements	36 Project Tracking Workspace	62. Knowledge Management System	88. Real Estate Management System
12 Product and Marketing Requirements Planning	37 Room and Equipment Reservations	63. Missing Person Site	89. Stock Mutual Funds Management
13 Request for Proposal Software	38 Sales Lead Pipeline	64. Disaster Management Site	90. Careers and Employment Management System
14 Sports League Management	39. Yellow Pages & Business Directory	65. Job Management Site	91. Music Albums Management System
15 Absence Request and Vacation Schedule Management	40. Time & Billing	66. Financial Portfolio Management	92. Classified Ads Managements
16 Budgeting and Tracking Multiple Projects	41. Class Room Management	67. Market Research Management	93. Property Management System
17 Bug Database Management	42. Expense Report Database	68. Order Management System	94. Sales & Retail Management
18 Call Center Management Software	43. Sales Contact Management Database	69. Point of Sale	95. Dating Site
19 Change Request Management	44. Inventory Management Database	70. Advertisement /Banner Management and Analytics	96. Hotel Management System
20 Compliance Process Support Site	45. Issue Database	71. Export Management System	97. Search Engine
21 Contacts Management Software	46. Event Management Database	72. Invoice Management	98. Online News Paper Site
22 Document Library and Review	47. Service Call Management Database	73. Recruitment Management System	99. Image Gallery
23 Event Planning and Management	48. Accounting Ledger Database	74. Articles / Blog / Wiki Web site	100. Staffing and Human Capital Management
24 Expense Reimbursement and Approval	49. Asset Tracking Database	75. Online Planner	101. Development of a feature-rich, practical Online Survey Tool (OST)
25 Help Desk and Ticket Management	50. Cycle Factory Works Management	76. Mock Tests and Examination Management	102 Development of a Web/Email based Search Engine
26 Inventory Tracking	51. Sales Corporation Management	77. Examination System	103. Development of a web-based Recruitment Process System for the HR group for a company

Text Books:

1. Dr. R. Nageswara Rao,” Core Python Programming” , Dreamtech Press, Wiley Publication
2. M. T. Savaliya , R. K. Maurya, “Programming through Python”, StarEdu Solutions.
3. E Balagurusamy, “Introduction to computing and problem-solving using python”, McGraw Hill Publication.

References:

1. Zed A. Shaw, “Learn Python 3 the Hard Way”, Zed Shaw's Hard Way Series.
2. Martin C. Brown,” Python: The Complete Reference”, McGraw-Hill Publication.
3. Paul Barry,” Head First Python”, 2nd Edition, O'Reilly Media, Inc.

Online resources:

1) https://docs.scipy.org/doc/numpy/user/quickstart.html
2) https://matplotlib.org/tutorials/
3) https://pandas.pydata.org/docs/getting_started/
4) https://www.geeksforgeeks.org/python-build-a-rest-api-using-flask/

Term Work:
The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus**.**

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM401	Mini Project – 1 B for Python based automation projects	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual’s as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria’s and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria’s in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual’s as member or leader
8. Clarity in written and oral communication

Syllabus upload as per letter No.AAMS/ICD/290, dt.15-11-21

University of Mumbai

No. AAMS (UG)/77 of 2021-22

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/42 of 2018-19 dated 25th June, 2021 relating to the revised syllabus as per the (CBCS) for the T.E. & B.E. in Electronics & Telecommunication Engineering (Sem V to VIII).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics & Telecommunication Engineering at its meeting held on 28th April, 2021 and subsequently made by the Board of Deans at its meeting held on 11th June, 2021 vide item No.6.5 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 **vide** item No. 6.5 (R) and that in accordance therewith, the revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Electronics & Telecommunication Engineering (T.E. - Sem. V & VI) has been brought into force with effect from the academic year 2021-22. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
30th September, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.5/29/06/2021

****

No. UG/77 -A of 2021-22 MUMBAI-400 032 30th September, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics & Telecommunication Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

AC 29/6/2021
Item No. 6.5

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC 29/6/2021

Item No. 6.5

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year in Bachelor of Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~ / **Revised** (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date **29-06-2021**

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 ‘C’ Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ECC501	Digital Communication	3	--	--	3	--	--	3
ECC502	Discrete Time Signal Processing	3	--	--	3	--	--	3
ECC503	Digital VLSI	3	--	--	3	--	--	3
ECC504	Random Signal Analysis	3	--	1	3	--	1	4
ECCDLO 501X	Department Optional Course-1	3	--	--	3	--	--	3
ECL501	Digital Communication Lab	--	2	--	--	1	--	1
ECL502	Discrete Time Signal Processing Lab	--	2	--	--	1	--	1
ECL503	Digital VLSI Lab	--	2	--	--	1	--	1
ECL504	Professional Communication & Ethics - II	--	2*+2$^{\sim}$	--	--	2	--	2
ECM501	Mini Project 2A- Embedded System Project	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

*** Theory should be conducted for the full class.**

$^{\sim}$ **Batch-wise practical's to be conducted**

$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract. & oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ECC501	Digital Communication	20	20	20	80	3	--	--	100
ECC502	Discrete Time Signal Processing	20	20	20	80	3	--	--	100
ECC503	Digital VLSI	20	20	20	80	3	--	--	100
ECC504	Random Signal Analysis	20	20	20	80	3	25	--	125
ECCDLO 501X	Department Level Optional Course-1	20	20	20	80	3	--	--	100
ECL501	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL502	Discrete Time Signal Processing Lab	--	--	--	--	--	25	25	50
ECL503	Digital VLSI Lab	--	--	--	--	--	25	25	50
ECL504	Professional Communication & Ethics-II	--	--	--	--	--	25	25	50
ECM501	Mini Project 2A- Embedded System Project	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**150**	**125**	**775**

Department Level Optional Course-1

Course Code	Department Level Optional Course-1
ECCDLO5011	Digital and IPTV Engineering
ECCDLO5012	Data Compression and Cryptography
ECCDLO5013	IT Infra and Security
ECCDLO5014	Data Structures and Algorithm
ECCDLO5015	Sensor Technology

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC601	Electromagnetics and Antenna	3	--	--	3	--	--	3
ECC602	Computer Communication Networks	3	--	--	3	--	--	3
ECC603	Image Processing and Machine Vision	3	--	--	3	--	--	3
ECC604	Artificial Neural Network and Fuzzy Logic	3	--	--	3	--	--	3
ECCDLO 601X	Department Level Optional Course-2	3	--	--	3	--	--	3
ECL601	Electromagnetics and Antenna Lab	--	2	--	--	1	--	1
ECL602	Computer Communication Networks Lab	--	2	--	--	1	--	1
ECL603	Image Processing and Machine Vision Lab	--	2	--	--	1	--	1
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	4	--	--	2	--	2
ECM601	Mini Project 2B- FPGA based Project	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**--**	**15**	**07**	**--**	**22**

$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC601	Electromagnetics and Antenna	20	20	20	80	3	--	--	100
ECC602	Computer Communication Networks	20	20	20	80	3	--	--	100
ECC603	Image Processing and Machine Vision	20	20	20	80	3	--	--	100
ECC604	Artificial Neural Network and Fuzzy Logic	20	20	20	80	3	--	--	100
ECCDLO 601X	Department Level Optional Course-2	20	20	20	80	3	--	--	100
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	--	25	25	50
ECL602	Computer Communication Networks Lab	--	--	--	--	--	25	25	50
ECL603	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	--	--	--	--	25	25	50
ECM601	Mini Project 2B- FPGA based Project	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**125**	**125**	**750**

Department Level Optional Course-2

Course Code	Department Level Optional Course-2
ECCDLO6011	Mixed Signal VLSI
ECCDLO6012	Computer Organization and Architecture
ECCDLO6013	Digital Forensic
ECCDLO6014	Database Management System
ECCDLO6015	IoT and Industry 4.0
ECCDLO6016	Radar Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC501	Digital communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC501	Digital communi-cation	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC401 - Engineering Mathematics-IV
ECC404 - Signals and Systems
ECC405 - Principles of Communication Engineering

Course Objectives:

1. To describe the basics of information theory and source coding.
2. To illustrate various error control codes.
3. To describe baseband system.
4. To learn different digital modulation and demodulation techniques

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply the concepts of information theory in source coding.
2. Compare different error control systems and apply various error detection codes.
3. Analyze different error correction codes.
4. Compare various baseband transmission methods for digital signals.
5. Evaluate the performance of optimum baseband detection in the presence of white noise.
6. Compare the performances of different digital modulation techniques

Module No.	Unit No.	Topics	Hrs.
1.0		**Information Theory and Source Codes**	**05**
	1.1	Block diagram of digital communication system, Information content of a source symbol, Source entropy, Average information rate, AWGN channel, and Shannon-Hartley channel capacity theorem.	03
	1.2	Introduction of source code, Huffman code, Shannon-Fano code.	02
2.0		**Error Control System and Error Detection Codes**	**03**
	2.1	Introduction of error control system, Automatic Retransmission Query (ARQ) system, Types of ARQ systems and comparison, Forward error correction (FEC) system. Comparison between FEC and ARQ.	01
	2.2	Error detection codes: Vertical Redundancy Check (VRC) code, Longitudinal Redundancy Check (VRC) code, Cyclic Redundancy Check (CRC) code and Checksum code.	02
3.0		**Error Correction Codes**	**10**
	3.1	Linear block code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder.	03
	3.2	Cyclic code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder.	03
	3.3	Convolutional code: Generation, path responses, encoder, state transition table, state diagram, tree diagram, trellis diagram, decoding using Viterbi's algorithm.	04
4.0		**Baseband Transmission**	**05**
	4.1	Block diagram of baseband transmitter-receiver system, Line codes (RZ and NRZ UniPolar formats, RZ and NRZ Polar formats, NRZ Bipolar format (AMI format), NRZ Manchester format, and Quaternary Polar format). Comparison of line codes with respect to bandwidth, power requirement, synchronization capability, DC level, polarity inversion error and complexity. Power spectral density and spectrum of NRZ Unipolar and Polar formats.	03
	4.2	Inter Symbol Interference (ISI), Inter Channel Interference (ICI). Nyquist criterion for distortionless baseband binary transmission, Nyquist bandwidth and practical bandwidth.	02
5.0		**Optimum Detection of Baseband Signal**	**04**
	5.1	Matched filter, Output SNR, Transfer function, Impulse response and Error probability. Integrate and dump receiver, Correlator receiver.	04
6.0		**Digital Modulations**	**12**
	6.1	Generation, Detection, Error probability (using signal space representation and Euclidean distance), Bandwidth (using PSD and spectrum except for MSK) and applications of the following modulations: Binary ASK, Binary PSK, Quadrature PSK, Off-Set QPSK, M-ary PSK, Binary FSK, M-ary FSK, 16-ary QASK and MSK.	12
		Total	**39**

Text Books:

1.H. Taub, D. Schlling, and G. Saha-Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.
3. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.
4. John G. Proakis-Digital Communications, McGraw-Hill, Fourth Edition

Reference Books:

1. Sklar B, and Ray P. K.-Digital Communication: Fundamentals and applications, Pearson,Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal-Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2012.
3. P Ramakrishna Rao-Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2011.
4. K. Sam Shanmugam-Digital and analog communication Systems, John Wiley and sons.
5. Upamanyu Madhow- Fundamentals of Digital Communication- Cambridge University Press
6. W.C. Huffman, Vera Pless- Fundamentals of Error Correcting Codes, Cambridge University Press
7. Graham Wade-Coding Techniques, Palgrave, New York

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/108/101/108101113/
2. https://nptel.ac.in/courses/108/102/108102096/
3. https://nptel.ac.in/courses/108/102/108102120/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Discrete-Time Signal Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC502	Discrete-Time Signal Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC404 Signals & Systems

Course Objectives:

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce applications of digital signal processing in the field of biomedical and audio signal processing.

Course Outcomes:

After successful completion of the course student will be able to:

1. Recall the system representations and understand the relation between different transforms.
2. Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
3. Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole-zero representations to choose a particular filter for the given application.
4. Interpret the different realization structures of Digital IIR and FIR filters.
5. Analyze the impact of hardware limitations on the performance of digital filters.
6. Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing.

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform & Fast Fourier Transform**	**08**
	1.1	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method	05
	1.2	Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	03
2.0		**IIR Digital filters**	**08**
	2.1	LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic	03
	2.2	Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	05
3.0		**FIR Digital Filters**	**09**
	3.1	Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems	04
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique – Type I low pass filter design, Comparison of IIR and FIR filters	05
4.0		**Digital Filter Structures**	**05**
	4.1	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter	02
	4.2	Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	03
5.0		**Finite Word Length Effects in Digital Filters**	**05**
	4.1	Rounding and truncation errors, Quantization error, Output noise power from a digital system	02
	4.2	Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	03
6.0		**Applications of Digital Signal Processing**	**04**
	6.1	Application of DSP for ECG and EEG signals analysis.	02
	6.2	Application of DSP for echo cancellation and sub-band coding of speech signal	02
		Total	**39**

Text Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference books

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach ", 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2006.
4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011
6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach",Wiley 2002.

NPTEL / Swayam Course:

1. Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
   http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2. Course: Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
   https://nptel.ac.in/courses/108/101/108101174/
3. Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105055/

Internal Assessment (20-Marks):

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End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC503	Digital VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC503	Digital VLSI	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits
ECC303 – Digital System Design
ECC403 – Linear Integrated Circuits

Course Objectives:

1. To introduce process flow of VLSI Design.
2. To understand MOSFET operation from VLSI design perspective.
3. To learn VLSI design performance metric and various tradeoffs.
4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles.
5. To provides an exposure to RTL design and programming

Course Outcomes:

After successful completion of the course student will be able to:

1. Know various tools and processes used in VLSI Design.
2. Explain working of various CMOS combinational and sequential circuits used in VLSI Design.
3. Derive expressions for performance parameters of basic building blocks like CMOS inverter.
4. Relate performance parameters with design parameters of VLSI circuits.
5. Select suitable circuit and design style for given application.
6. Design and realize various combinational and sequential circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Review of MOSFET operation and Fabrication**	**08**
	1.1	Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling, Short channel effects	03
	1.2	Fabrication process flow of NMOS and CMOS, Lambda based design rules	03
	1.3	Novel MOSFET Architectures FinFET, GAA-FET, CNTFET	02
2.0		**Combinational CMOS Logic Circuits**	**06**
	2.1	CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter	03
	2.2	Realization of CMOS NAND gate, NOR gate, Complex CMOS Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits	03
3.0		**MOS Design Logic Styles**	**09**
	3.1	Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C^2MOS	04
	3.2	Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS –JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles	03
	3.3	Realization of Shift Register, MUX, Decoder using above design styles ,1-bit full adder	02
4.0		**Semiconductor Memories**	**06**
	4.1	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM	03
	4.2	Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	03
5.0		**Data path and system design issues**	**06**
	5.1	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier	04
	5.2	On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk	02
6.0		**RTL Design**	**04**
	6.1	High Level state machines, RTL design process	02
	6.2	RTL design of Soda dispenser machine, FIR Filter	02
		Total	**39**

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition.
3. Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.

Reference Books:

1. Neil H. E. Weste, David Harris and Ayan Banerjee, —*CMOS VLSI Design: A Circuits and Systems Perspective*‖, Pearson Education, 3rd Edition.
2. John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", Wiley, Student Edition, 2013.
3. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Random Signal Analysis	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC504	Random Signal Analysis	20	20	20	80	03	25	--	125

Course Pre-requisite:

ECC401- Engineering Mathematics IV
ECC404 - Signals and Systems

Course Objectives:

1. To strengthen the foundations of probability
2. To teach continuous and discrete random variables.
3. To explain statistical behavior of one dimensional and two dimensional random variables.
4. To describe the concept of random process which is essential for random signals and systems encountered in Communications and statistical learning.
5. To develop problem solving skills and explain how to make the transition from a real world problem to a probabilistic model.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply theory of probability in identifying and solving relevant problems.
2. Differentiate continuous and discrete random variables and their distributions.
3. Analyze mean, variance, and distribution function of random variables and functions of random variables.
4. Define a random process, determine the type of the process and find the response of LTI system for WSS process.
5. Explain linear regression algorithms and apply for predictive applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Concepts in Probability**	**04**
	1.1	Definitions of probability, joint, conditional, and total probability, Bayes' theorem, independence of events, binary symmetric communication channel analysis using Bayes' theorem.	
2.0		**Introduction to Random Variables**	**08**
	2.1	Continuous, discrete, and mixed random variables, probability density function, probability distribution function, and probability mass function, properties of PDF and CDF	
	2.2	Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh Distributions Mean, variance and moments of random variables	
3.0		**Operations on One Random Variable**	**08**
	3.1	Function of a random variable and their distribution and density functions.	
	3.2	Expectation, variance, moments, and characteristic function of random variable.	
	3.3	Transformation of a random variable, Markov and Chebyshev inequality, characteristic functions, moment theorem.	
4.0		**Multiple Random Variables and Convergence**	**08**
	4.1	Pairs of random variables, joint CDF and joint PDF.	
	4.2	One function of two random variables; joint moments, covariance and correlation-independent, uncorrelated and orthogonal random variables.	
	4.3	Central limit theorem and its significance	
5.0		**Random Processes**	**06**
	5.1	Definitions, statistics of stochastic processes, n^{th} order distribution, second-order properties: mean and autocorrelation, Poisson process, normal processes, SSS, WSS.	
	5.2	Mean and correlation ergodic processes, transmission of WSS through LTI system, introduction to Markov process.	
6.0		**Introduction to Statistical Learning and Applications**	**05**
	6.1	Regression and model building, simple linear regression, multiple linear regression, least square estimation of the coefficients, residual calculations.	
	6.2	Applications of simple linear regression in prediction of new observations.	
		Total	**39**

Text Books:

1. T. Veerarajan, "Probability, Statistics and Random Process", Tata McGraw Hill Education, Third Edition (2018).
2. Athanasios Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Processes", Tata McGraw Hill Education
3. Henry Stark & John Woods, "Probability, Statistics, and Random Processes for Engineers, 4th Edition, Pearson Education, 2012

4. Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining, “Introduction to linear regression Analysis”, student edition, Wiley publications.

Reference Books

1. Scott Miller and Donald Childers, “Probability and Random Processes with Applications to Signal Processing and Communications”, Elsevier Publication.
2. Hwei Hsu, “Theory and Problems of Probability, Random Variables, and Random Processes”, Schaum’s Outline Series, McGraw Hill, 1997.
3. P. Ramesh Babu, “Probability Theory and Random Process”, Tata McGraw Hill Education.
4. Alberto Leon Garcia, “Probability and Random Processes for Electrical Engineering”, second edition , Pearson education.
5. Daniela Witten, Trevor Hastie , Robert Tibshirani, “An Introduction to Statistical Learning by Gareth James”, 7th Edition, Springer 2017.
6. Ronald Walpole, et. al., “Probability and Statistics for Engineers and Scientists”, 8th edition, Pearson Education.
7. P. Kousalya, “Probability, Statistics, and Random Processes”, Pearson Education.

NPTEL / Swayam Course:

1. Introduction to probability and Statistics, Prof. G. Srinivasan (IIT Madras); https://onlinecourses.nptel.ac.in/noc21_ma01/preview
2. Probability and Probability Distributions By Dr. P.Nagesh: https://onlinecourses.swayam2.ac.in/cec21_ma02/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 08 Tutorials covering entire syllabus must be given during the “Class Wise Tutorial”. Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per “Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5011	Digital and IP TV Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ECCDLO 5011	**Digital and IP TV Engineering**	20	20	20	80	03	--	--	100

Prerequisite:

1. Basics of various Television standards and operation
2. TCP/IP Protocol
3. Basics of conventional video camera and standards

Course Objectives:

1. To provide in depth knowledge about Digital Television system
2. To familiarize students' various types of advanced types of Video cameras and Displays
3. To introduce the students to different television standards and applications
4. Acquaintance with HDTV and 3D TV system
5. To familiarize the students to IPTV, Its architecture, Protocols and hardware
6. To Introduce students to IP delivery networks, threats and mitigation

Course Outcomes:

After successful completion of the course student will be able to:

1) Understand the working principles of advanced digital television systems.
2) Enable to choose or develop an appropriate camcorder and displays based on applications.
3) Familiar with current digital TV standards.
4) Evaluate the Stereoscopic images and binocular depth perception.
5) Acquire knowledge of IPTV and develop hardware and protocols.
6) Ability to provide customized IPTV services to end user.

Module No	Unit No	Topics	Hrs
1		**Fundamentals of Digital Television**	**7**
	1.1	Fundamentals of colour television, Compatibility, and reverse compatibility, colour perception, Three colour theory, luminance, hue and saturation. Interlaced scanning, Composite video signal	
	1.1	Introduction to Digital TV, Digital TV signals and parameters	
	1.2	Digital TV transmitter and Receiver its merits and demerits	
	1.3	MAC Signals and advanced MAC Signal Transmission	
	1.4	Digitization, Chroma sub sampling, Digital audio compression techniques and video compression techniques MPEG1,MPEG2,H.264,MPEG- 4,AVC,H.265, SMPTE 421M,	
	1.5	Set Top Box with recording	
2		**Digital Video Cameras, Displays and Streaming media device**	**5**
	2.1	Colour TV Digital cameras, Camcorders, Handycams, and Digicams	
	2.2	LED, LCD, OLED, PLASMA, Quantum Dot LED Displays	
	2.3	Chromecast	
	2.4	Consumer applications: DVD, Blue ray DVD	
3		**Digital TV standards and advanced TV**	**8**
	3.1	DVB-T, and its successors	
	3.2	ISDB -T	
	3.3	ATSC	
	3.4	ISD TV	
	3.5	DTMB	
	3.6	Ultra HDTV	
	3.7	CCTV	
	3.8	Direct to Home TV(DTH)	
	3.9	Smart TV and its functions	
	3.10	3D TV	
4		**IPTV**	**6**
	4.1	Introduction to IPTV	
	4.2	IP TV hardware	
	4.3	Features of IPTV	
	4.4	Architecture of IPTV	
	4.5	Bandwidth requirement	
	4.6	IPTV Set top Box, Smart TV comparison	
5		**IP TV Protocols and Applications**	**9**
	5.1	Internet Group Management Protocol (IGMP)	
	5.2	Real-Time Streaming Protocol (**RTSP**)	
	5.3	Real-Time Messaging Protocol (**RTMP**)	
	5.4	Hypertext Transfer Protocol (HTTP).	
	5.5	Applications of IPTV	

	5.6	IPTV Delivery: Broad cast. Unicast, Multicast	
	5.7	IPTV Streaming: Time Shifted Stream-On -the- fly streaming	
	5.8	experimental framework used for evaluating the classification algorithm	
	5.9	Experimental framework for evaluating the classification algorithm (Self learning) Configuring IPTV to android phone, Tablet, Television and Computer(Self Learning)	
6		**IPTV Network Security: Threats and Countermeasures**	**4**
	6.1	Threats on IPTV Delivery Networks, Theft or Abuse of Network Assets, Theft of Service, Theft of IPTV-Related Data, Disruption of Service, Privacy Breach, Compromise of Platform Integrity	
	6.2	Security Issues of IPTV Delivery Networks: Protocols Vulnerabilities, Countering the threats	
	6.3	Advantages and disadvantages of IPTV	
	6.4	Future of IPTV	
		Total	**39**

Textbooks:

1.Television and video Engineering, A. M. Dhake, Tata McGraw Hill Publication.

2. Video Demystified, Kelth jack, Hand book for digital engineers, Newness, Elsevier

3.Digital Television Systems. Marcelo S. Alencar, Cambridge University Press

4.Understanding IPTV, Gilbert Held, CRC Press

Reference Books:

1.The digital evolution of Television, D. Gerbarg, Springer

2. Applications and Usability of interactive TV, Maris Jos Abisolo, Springer

3. IPTV Delivery network, Suliman Mohamed Fati, Saiful Azad, Al-Sakib Khan Pathan, Wiley Publications

4. Television Engineering & Video Systems, R. G. Gupta, McGraw Hill Publication

5. Quantum dot based light emitting diodes, Morteza Sasani Ghamsari, Google book

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	**Course Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ECCDL O5012	Data Compression and Cryptography	03	--	--	03	--	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Exam. Duration (in Hrs)**	**Term Work**	**Practical and Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Avg. Of Test 1 and Test 2**					
ECCDL O5012	Data Compression and Cryptography	20	20	20	80	03	--	--	100

Course Objectives:

1. Gain a fundamental understanding of data compression methods for text, images, video and audio.
2. Understand the concepts of cryptography and different algorithms to provide system security.

Course Outcomes:

After successful completion of the course student will be able to

1. Apply various compression techniques for text and understand image compression and its standards.
2. Select suitable compression techniques for specified lossless and lossy audio and video applications.
3. Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards.
4. Apply number theory concepts to solve the cryptographic problems.
5. Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6. Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Data Compression**	**06**
	1.1	Data compression, modelling and coding, Lossless and Lossy Compression, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW.	
	1.2	Image Compression DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards.	
2.0		**Video and Audio Compression**	**06**
	2.1	Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder.	
	2.2	Sound, Digital Audio, μ-Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard.	
3.0		**Data Security**	**10**
	3.1	Security Goals, Cryptographic Attacks and Techniques	
	3.2	Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher	
	3.3	DES, double DES and triple DES, AES	
4.0		**Number Theory**	**04**
	4.1	Prime Numbers, Fermat's and Euler's Theorem.	
	4.2	Chinese Remainder Theorem	
5.0		**Asymmetric Key Cryptography**	**09**
	5.1	Principles of Public Key Crypto System, RSA, Key Management, Deffie-Hellman Key Exchange.	
	5.2	Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards.	
6.0		**System Security**	**04**
	6.1	Intrusion Detection System, Secure Electronic Transactions.	
	6.2	Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking.	
		Total	**39**

Textbooks:

1. Khalid Sayood , 3rd Edition, |Introduction to Data Compression|, Morgan Kauffman
2. Mark Nelson, Jean-Loup Gailly,‖The Data Compression Book‖, 2nd edition, BPB Publications
3. William Stallings ,|Cryptography and Network Security Principles and Practices 5th Edition‖, Pearson Education.
4. Behrouz A. Forouzan, |Cryptography and Network Security‖, Tata McGraw-Hill.

Reference Books:

1. 1. David Salomon, |Data Compression: The Complete Reference‖, Springer.
2. Matt Bishop, |Computer Security Art and Science‖, Addison-Wesley.
3. Bernard Menesez,| Network Security and Cryptography| Delmar Cengage Learning, 7th Edition.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5013	IT Infra & Security	**03**	**--**	**--**	**03**	**--**	**--**	**03**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5013	IT Infra & Security	20	20	20	80	03	--	--	100

Course prerequisite:

- **Principles of Communication**

Course Objectives:

1. **To introduce basic fundamentals of IT Infrastructure and its Management.**
2. **To develop underlying principles of infrastructure security.**
3. **To explore software vulnerabilities and attacks.**
4. **To introduce the protection mechanisms for operating systems and database security.**
5. **To explore the security aspects of wireless network infrastructure and protocols.**
6. **To investigate the different attacks on Web Applications and Web services.**

Course Outcomes: Students will be able to:

1. **Understand IT Infrastructure and its Management.**
2. **Understand the concept of Information securities.**
3. **Summarize the concepts of vulnerabilities, attacks and protection mechanisms.**
4. **Analyze software vulnerabilities and attacks on databases and operating systems.**
5. **Explain the need for security protocols in the context of wireless communication.**
6. **Analyze the different attacks on Open Web Applications and Web services.**

Module No.	Unit No.	Topics	Hrs
1.0		**Overview of Networks and IT Infrastructure**	**09**
	1.1	**Overview of OSI and TCP/ IP Networks, introduction to IP Addressing scheme, introduction to Networking Components**	
	1.2	**Information Technology, Design Issues of IT Organizations and IT Infrastructure, Information System Design Process, IT Infrastructure Management, Challenges in IT Infrastructure Management, Determining Customers, Requirements, Security controls and safeguards, IT security Plans.**	
2.0		**Introduction to Information Security**	**06**
		Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC, MAC, RBAC, BIBA, Bell La Padula), Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	
3.0		**Software Vulnerabilities**	**04**
		Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits	
4.0		**Operating System and Database Security**	**08**
	4.1	**Introduction operating system security, system security planning, Application security, Linux/ Unix security, Windows, security, Security Maintenance,**	
	4.2	**Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security**	
5.0		**Wireless Security**	**05**
		The need for Wireless Network Security, Attacks on Wireless Networks, Security services, WEP & WPA protocols, Mobile IP, Virtual Private Network (VPN): PPTP, L2TP, IPSec	
6.0		**Web Security**	**07**
		Introduction: Transport Protocol and Data Formats, Web Browser, Threat Model **Authenticated Sessions: Cookie Poisoning, Cookies and Privacy, Making Ends Meet** **Code Origin Policies, Cross-Site Scripting: Cookie Stealing, Defending against XSS, Cross-Site Request Forgery, JavaScript Hijacking**	
		Total	**39**

Text Books:

1. **Gupta, "IT Infrastructure & Its Management", First Edition, Tata McGraw-Hill Education.**
2. **Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education**
3. **Computer Security, Dieter Gollmann, Third Edition, Wiley Publications.**
4. **Data Communications and Networking, Forouzan, Fourth Edition, Mc Graw Hill Publication**
5. **Wireless Networks, P. Nicopolitidis, M.S. Obaidat, G.I Papadimitriou, A.S Pomportsis, Wiley Publications**

Reference Books:

1. **Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education**
2. **CCNA Security Study Guide, Tim Boyle, Wiley Publications**
3. **Introduction to Computer Security, Matt Bishop, Pearson.**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5014	Data Structure & Algorithm	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5014	Data Structure & Algorithm	20	20	20	80	03	--	--	100

Course pre-requisite:

ECL404 Skill Lab: Python Programming

Course Objectives:
The course aims:
1. To Introduce the fundamental knowledge & need of Data Structures.
2. To Abstract the concept of Algorithm and these concepts are useful in problem solving.
3. To Implement fundamental knowledge and applications of Stack, Queue, Linked List, Trees, Graphs etc.
4. To Understand the working of different Sorting, Searching & Hashing techniques.
5. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course Outcome:
After successful completion of the course the student will: -
1. Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis.
2. Apply various operations on Stack and Queue.
3. Ability to demonstrate the operation of Linked list.
4. Ability to demonstrate and apply Trees & Graph data structures.
5. Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6. Describe the hash function and concepts of collision and its resolution methods

Module No.	Unit No.	Topics	Hrs.
		Prerequisite: Control Structures, Arrays, Recursion, Pointers, Structures, Memory Allocation Techniques, Self-referential structures.	
1.0		**Introduction to Data Structure & Algorithm**	**5**
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures.	
	1.2	Algorithm: Performance characteristics of algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Introduction to Asymptotic Analysis and Notations.	
2.0		**Stack & Queue**	**8**
	2.1	Introduction to Stack, ADT of Stack, Operations on Stack, Array Implementation of Stack	
	2.2	Applications of Stack- Infix to Postfix Expression Conversion, Infix Expression to Prefix Expression Conversion, Postfix Expression Evaluation	
	2.3	Introduction to Queue, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction to Double Ended Queue	
	2.4	Applications of various types of Queue	
		Self-Learning Topic: Well form-ness of Parenthesis using Stack	
3.0		**Linked List**	**7**
	3.1	Introduction, Linked List v/s Array, Representation of Linked List, Types of Linked List - Singly Linked List, Doubly Linked List	
	3.2	Operations on Singly Linked List and Doubly Linked List	
	3.3	Singly Linked List Application-Polynomial Representation and Addition, Doubly Linked List Application	
		Self-Learning Topic: Stack and Queue using Singly Linked List	
4.0		**Trees & Graph**	**9**
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree,	
	4.2	Applications of Binary Tree- Expression Tree, Huffman Encoding.	
	4.3	**Graph:** Introduction, Graph Terminology, Memory Representation of Graph, Operations Performed on Graph.	
	4.4	Graph Traversal, Breadth First Search, Depth First Search, Applications of the Graph, Shortest Path, Minimum Spanning Tree.	
5.0		**Searching & Sorting**	**6**
	5.1	**Searching:** Sequential Search, Index Sequential Search, Binary Search	
	5.2	**Sorting:** Bubble Sort, Quick Sort, Merge Sort	
		Self-Learning Topic: Selection Sort, Insertion Sort	
6.0		**Hashing**	**4**
	6.1	Hashing-Concept, Hash Functions, Common hashing functions	
	6.2	Collision resolution Techniques	
		Total	**39**

Text Books:

1. Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and its Applications”, McGraw-Hill Higher Education

2. “Fundamentals of Computer Algorithms” Ellis Horowitz, Sartaj Sahani and Sanguthevar Rajasekaran, Second Edition, Universities Press (India) Pvt. Ltd.

3. “Learning with Python” Allen Downey, Jeffrey Elkner, Chris Meyers, Dreamtech Press

Reference Books:

1. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984

2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGrawHill Edition.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5015	Sensor Technology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 5015	Sensor Technology	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC202 – Engineering Physics-II
2. ECC302 -- Electronic Devices & Circuits
3. ECC403 - Linear Integrated Circuits

Course Objectives:

1. To understand various physical parameters and its sensing techniques
2. To familiarize about MEMS sensors and Actuators
3. To introduce wireless sensing technologies
4. To develop understanding about signal conditioning using ADC and DAC
5. To provide insight into various sensor applications

Course Outcome:

After successful completion of the course student will be able to

1. Understand the transduction principal of various sensors.
2. Select sensors suitable for required application
3. Analyze wireless sensing techniques
4. Design the data acquisition system
5. Identify signal conditioning method for particular application
6. Create an application using various sensor technologies

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**03**
	1.1	**Classification of Sensors :** The sensors are classified with criteria like primary physical quantity to be sensed , transduction principle, material and technology used and application	
	1.2	**Criteria to choose a Sensor:** Accuracy, Environmental condition, Range, Calibration, Resolution , Cost and Repeatability	
	1.3	**Digital sensors** : Principle and its advantage over analog sensors	
	1.4	**Smart Sensors:** Low-power, Self –diagnostic and Self- calibration	
2.0		**Types of Sensors**	**09**
	2.1	**Temperature Sensors :** RTD, Thermocouple and Thermistors sensor	
	2.2	**Proximity Sensors :** Inductive (LVDT), Capacitive, Photoelectric and Ultrasonic sensors	
	2.3	**Chemical Sensors :** Gas , Smoke, Conductivity and pH sensor	
	2.4	**Other Sensors :** Optical, Infrared (IR), Sound, Motion , Pressure , Level , Moisture, Humidity, Laser , Image and GPS sensor	
3.0		**MEMS Sensors and Actuators**	**06**
	3.1	**MEMS SENSORS:** General design methodology, techniques for sensing, Pressure sensor , Mass Flow sensor , Acceleration sensor , Angular Rate sensor and Gyroscopes, Micro machined microphones, Chemical sensors, Taguchi Gas sensor, Combustible Gas sensors	
	3.2	**MEMS ACTUATORS:** Techniques for actuation, Digital Micro mirror Device, Micro Machined Valves	
4.0		**Wireless Sensing Technologies**	**05**
	4.1	**Bluetooth:** Concepts of Pico net, Scatter net, Link types, Network connection establishments	
	4.2	**ZigBee:** components, architecture, network topologies	
	4.3	**Ultra Wide Band (UWB), Near Field Communication (NFC) and RFID:** technical requirements, components and characteristics	
	4.4	**WLAN (WiFi) :** WLAN Equipment, WLAN topologies , IEEE 802.11 Architecture	
5.0		**Data Acquisition and Signal Conditioning**	**08**
	5.1	**Fundamentals of Data Acquisition:** Analog and Digital data acquisition system with different configurations, Data loggers, Noise and interference	
	5.2	**Signal Conditioning :** Wheatstone Bridge, Flash ADC, R2R DAC	
	5.3	Utilization of Signal conditioning circuits for Temperature, Pressure, Optical, Strain gauges, Displacement and piezoelectric Transducers	
6.0		**Sensor Applications**	**08**
	6.1	Onboard Automobile sensing system, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring, Biomedical Sensing Applications	
	6.2	Radio sensors for industrial applications, Radio Astronomy, Remote Sensing, Ground Penetrating Radars, Underwater sensing, LIDAR	
		Total	**39**

Textbooks:

1. D.V.S. Murthy, "Transducers and Instrumentation", PHI Learning, 2nd Edition, 2013.
2. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
3. Antti V. Raisanen, Arto Lehto, "Radio Engineering for Wireless Communication and Sensor Applications", Artech House mobile communications series, USA, 2003.

4. Sensors and Signal Conditioning, Ramon Pallas Areny, John G. Webster, 2nd edition, John Wiley and Sons, 2000.
5. Vijay K. Garg, “Wireless Communication and Networking”, Morgan -Kaufmann Series in Networking, Elsevier, 2010.

Reference Books:

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, 2004.
2. Micro Electro Mechanical System Design, James J. Allen, Taylor and Francis, 2005
3. A.K. Sawhney, “A Course in Electrical and ElectronicMeasurements and Instrumentation”, Dhanpatrai & Co., 19th Edition, 2011.
4. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020
5. Instrumentation Devices and System, C.S. Rangan, G.R. Sarma, V.S. Mani, TMH,1997.
6. Jacob Fraden Handbook of Modern Sensors Physics, Designs, and Applications Fourth Edition, Springer, 2010.

NPTEL / Swayam Course :

https://nptel.ac.in/courses/108/108/108108147/ https://www.youtube.com/watch?v=vjhp0zTXEsc

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL501	Digital Communication Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL501	Digital communication Lab	--	--	--	--	25	25	50

Course objectives:

1. To learn source coding and error control coding techniques
2. To compare different line coding methods
3. To distinguish various digital modulations
4. To use different simulation tools for digital communication applications

Course outcomes:

After the successful completion of the course student will be able to

1. Compare various source coding schemes
2. Design and implement different error detection codes
3. Design and implement different error correction codes
4. Compare various line coding techniques
5. Illustrate the impulse response of a matched filter for optimum detection
6. Demonstrate various digital modulation techniques

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Huffman code generation
2. Shannon-Fano code generation
3. Vertical redundancy Check (VRC) code generation and error detection
4. Horizontal Redundancy Check (HRC) code generation and error detection
5. Cyclic redundancy Check (CRC) code generation and error detection
6. Checksum code generation and error detection
7. Compare the performances of HRC and Checksum
8. Linear block code generation and error detection
9. Error detection and correction using Hamming code virtual lab http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php
10. Cyclic code generation and error detection
11. Convolutional code generation

12. Line Codes generation and performance comparison
13. Spectrum of line codes (NRZ unipolar and polar)
14. Impulse responses of ideal (Nyquist filter) and practical (Raised cosine filter) solution for zero ISI
15. Matched filter impulse response for a given input
16. Generation (and detection) of Binary ASK
17. Generation (and detection) of Binary PSK
18. Generation (and detection) of Binary FSK
19. Generation (and detection) of QPSK
20. Generation (and detection) of M-ary PSK
21. Generation (and detection) of M-ary FSK
22. Generation (and detection) of 16-ary QASK
23. Generation (and detection) of MSK

Term Work, Practical and Oral:

At least 8 experiments covering the entire syllabus must be given "**Batch Wise"**. The experiments can be conducted with the help of simulation tool (preferably open source) and breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL502	Discrete-Time Signal Processing Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL502	Discrete-Time Signal Processing Laboratory	--	--	--	--	25	25	50

Course objectives:

1. To carryout basic discrete time signal processing operations.
2. To implement and design FIR filters and IIR filters.
3. To implement applications related to the field of biomedical signal processing and audio signal processing.

Course outcomes:

Learners will be able to …

1. Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
2. Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
3. Design and implement the FIR and IIR Filters for given specifications.
4. Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Suggested list of experiments:

1) To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals and random noise and interpret the results obtained.
2) To linearly convolve swept frequency sinusoidal wave with LPF and HPF impulse response filters in time domain and interpret the results obtained.

3) To obtain cross correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).
4) To perform block convolution using overlap - add method and overlap-save method.
5) To determine impulse, magnitude, phase response and pole-zero plot of given transfer functions.
6) To perform circular convolution and linear convolution of two sequences using DFT.
7) To perform the DFT of DT sequence and sketch its magnitude and phase spectrum or To Generate a discrete time signal having minimum three frequencies and analyse its frequency spectrum.
8) To study the effect of frequency resolution and zero padding.
9) DFT based spectral analysis to detect the signal buried in noise.
10) To perform denoising of a speech signal using circular convolution.
11) Design of IIR digital filters and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc).
12) Design a notch filter to supress the power supply hum in audio signals.
13) Design a comb filter to suppress 50Hz hum in biomedical signals.
14) Design of FIR filter using windowing method and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc.
15) Design of FIR filter using frequency sampling technique.
16) Design of minimum phase, maximum phase and mixed phase systems.
17) To verify the location of zeros in symmetric and antisymmetric FIR filters.
18) To reconstruct DT signals contaminated with sinusoidal interference using FIR filters.
19) To realise an IIR filter in cascade and parallel form.
20) To obtain lattice parameters of a given transfer function (FIR and IIR systems).
21) To perform coefficient quantisation using truncation and rounding.
22) To study the effect of coefficient quantisation on the frequency response of an IIR filter.
23) To study the effect of coefficient quantisation on the frequency response of an FIR filter.
24) To investigate the behaviour of limit cycle in an IIR system.
25) To generate the ECG signal and detect the characteristic points.
26) Classification of ECG signals.
27) To read an ECG signal and separate the QRS Complex.
28) To filter out the noise in an ECG signal using Spectral subtraction.
29) To extract delta, theta, alpha, sigma, and beta waveforms from EEG signal.
30) Perform sub-band coding on speech signal.
31) To generate Echo, Reverberation, Flanging effects in a sound signal.
32) Musical tone generation.
33) DTMF tone generation and detection.
34) Echo cancellation.

Also check

Virtual Laboratory http://vlabs.iitkgp.ernet.in/dsp/# for demonstration of concepts like DFT and its inverse, FIR filter using windowing method etc

Term Work:

At least 08 experiments covering the entire syllabus must be given "Batch Wise" and implemented using any software namely C, Python, Scilab, Matlab, Octave, etc. The experiments should be set to have well predefined inference and conclusion. Application oriented one course-project can be conducted for maximum batch of four students. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and averaged. Based on above scheme, grading and term work assessment should be done. Practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 08 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL503	Digital VLSI Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL503	Digital VLSI Lab	--	--	--	--	25	25	50

Course objectives:

1. To become familiar with open source circuit simulation tools like Ngspice, Magic etc.
2. To perform various type of analysis of combinational and sequential CMOS circuits
3. To evaluate performance of given combinational and sequential CMOS circuits
4. To design, implement and verify combinational and sequential CMOS circuits using open source VLSI design tools.

Course outcomes:

After the successful completion of the course student will be able to

1. Write spice code for given combinational and sequential CMOS circuits.
2. Perform various analysis like operating point, dc, transient etc of given CMSO circuits.
3. Evaluate performance of given CMOS circuits.
4. Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic.
5. Design, simulate, and verify CMOS circuit for given specifications.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Constant Voltage and Constant field MOSFET scaling
2. Layout of MOSFET and extraction of parasitic capacitances
3. Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power
4. Transient Analysis of CMOS inverter and calculation of tpHL, tpLH, tr, tf, average power
5. Design of CMOS inverter for given specifications
6. Layout of CMOS inverter and comparison of pre layout and post layout performance.
7. Voltage transfer characteristics of 2 input NAND/NOR gate and calculation of noise margins and validation using equivalent inverter approach.
8. Transient Analysis of 2 input NAND/NOR CMOS gate and calculation of tpHL, tpLH, tr, tf, average power and validation using equivalent inverter approach.

9. Layout of 2 input CMOS NAND/NOR gate and comparison of pre layout and post layout performance.
10. Static and transient analysis of Complex CMOS gate.
11. Layout of complex CMOS gate using euler path.
12. Implementation of various combinational and sequential circuits using different design styles.
13. Design and implementation of NAND based and NOR based ROM array.
14. Performance analysis of 6T-SRAM Cell
15. Design of 6T SRAM cell robust read and write operation.
16. Performance analysis of 1T and 3T DRAM Cell
17. RTL design of Soda dispenser machine
18. RTL design of FIR Filter

Link for virtual lab
http://www.vlsi-iitg.vlabs.ac.in

Term Work, Practical and Oral:

At least 8 experiments (at least three experiments on layout) covering the entire syllabus must be given "**Batch Wise**". The experiments can be conducted with the help of simulation tool (preferably. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECL504	Professional Communication & Ethics-II	--	2*+ 2 Hours (Batch-wise)	--	--	2	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ECL504	Professional Communication & Ethics-II (abbreviated PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ECL504	Business Communication & Ethics	02
Course Rationale	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	• To discern and develop an effective style of writing important technical/business documents. • To investigate possible resources and plan a successful job campaign. • To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. • To develop creative and impactful presentation skills. • To analyze personal traits, interests, values, aptitudes and skills. • To understand the importance of integrity and develop a personal code of ethics.	

Course Outcomes	**Learner will be able to…** • plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. • strategize their personal and professional skills to build a professional image and meet the demands of the industry. • emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. • deliver persuasive and professional presentations. • develop creative thinking and interpersonal skills required for effective professional communication. • apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)** **1.1 Purpose and Classification of Reports:** **Classification on the basis of:** • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long) **1.2. Parts of a Long Formal Report:** • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter) **1.3. Language and Style of Reports** • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers **1.4. Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) **1.5. Parts of a Proposal** • Elements • Scope and Limitations • Conclusion	06

	1.6. Technical Paper Writing • Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) • Language and Formatting • Referencing in IEEE Format	
2	**EMPLOYMENT SKILLS** **2.1. Cover Letter & Resume** • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination) **2.2 Statement of Purpose** • Importance of SOP • Tips for Writing an Effective SOP **2.3 Verbal Aptitude Test** • Modelled on CAT, GRE, GMAT exams **2.4. Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays) • GD Etiquettes **2.5. Personal Interviews** • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	**06**
3	**BUSINESS MEETINGS** **1.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	**02**

4	**TECHNICAL/ BUSINESS PRESENTATIONS** **1.1 Effective Presentation Strategies** • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills **1.2 Group Presentations** • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	**02**
5	**INTERPERSONAL SKILLS** **1.1. Interpersonal Skills** • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making **5.2 Start-up Skills** • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	**08**
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** • Copyrights • Trademarks • Patents • Industrial Designs • Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) **6.2 Case Studies** • Cases related to Business/ Corporate Ethics	**02**

List of assignments:
(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal

3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.
The distribution of marks for term work shall be as follows:

Assignment	: 10 Marks
Attendance	: 5 Marks
Presentation slides	: 5 Marks
Book Report (hard copy)	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	: 10 marks
Project Presentation	: 10 Marks
Group Dynamics	: 5 Marks

Books Recommended:

Textbooks and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow,

England: Pearson.

6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM501	Mini Project 2A: Embedded System Project	--	04$^{\$}$	--	--	02	--	02

$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Subject Code	Subject Name	Examination Scheme						
		Theory Marks						
		Internal Assessment			End Sem. Exam	Term Work	Practical and Oral	Total
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECM501	Mini Project 2A: Embedded System Project	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC402- Microcontrollers
2. ECC403- Linear Integrated Circuits
3. ECM401- Mini Project 1B: Arduino & Raspberry Pi based Projects

Course Objectives

1. To develop background knowledge Embedded Systems.
2. To understand designing of embedded systems.
3. To choose proper microcontroller for Embedded systems
4. To understand use of wireless sensors/communications with Embedded systems
5. To understand communication techniques.
6. To write programs for embedded systems and real time operating systems /IoT

Course Outcomes

After successful completion of the course, the student will be able to

1. Understand the embedded systems with design metrics.
2. Understand microcontrollers and programming in Embedded C.
3. Implementation of Embedded systems with different sensors and peripherals as IoT.
4. Implementation of Embedded systems with different communication protocols as IoT.
5. Analyze concepts of Real time operating systems.
6. Design embedded system applications using sensors, peripherals and RTOS

A. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects.Students should do survey of different microcontroller board from given microcontroller series, tools and identify which is most suitable for their selected topic. They should consult with their Guide/Mentors / Internal committee to finalize it.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
3. A log book to be prepared by each group, wherein group can record weekly work progress. Guide/ supervisor will verify it and will put notes/comments.

4. Guide/supervisor guidance is very much important during mini project activities; however, focus shall be on self-learning.
5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.
6. **Suggested steps for mini project selection and implementation**
    - i. Mini project should be completely microcontroller based
    - ii. Follow these steps
        - a) Take specification, using these specifications design project.
        - b) Select proper microcontroller board considering features and requirements of project.
        - c) Program it using Embedded C and perform verification of each module (sensors/communication protocol)
        - d) Test Functional Simulation and verify it using simulation tool.
        - e) Make hardware connection on GPP of peripherals with microcontroller board and execute the program.
        - f) Troubleshoot if not get expected result.

B. **Project Topic selection and approval :-**

1. The group may be of **maximum FOUR (04)** students.
2. Topic selection and approval by **2 Expert** faculty from department at the start of semester
3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.

C. **Project Report Format:**

1. Report should not exceed **30 pages**. Simply staple it to discourage use of plastic.
2. Report must contain block diagram, circuit diagram, screenshot of outputs and datasheets of microcontrollers and peripherals (Include **only required** information pages).
3. The recommended report writing format is in **LaTeX. (https://youtu.be/YLm3sXlKpHQ)**

Term Work:

1. **Term Work evaluation and marking scheme:**
    - a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
    - b. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
    - c. At end of semester the above 2 expert faculty who have approved the topic will internally **evaluate the performance**.
    - d. Students have to give presentation and demonstration on the Embedded Systems Mini Project- 2-A at end of semester before submission to above experts.
    - e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.

    - **f. Distribution of 25 Marks scheme is as follows:**
        - i. Marks awarded by guide/supervisor based on log book and output : 10
        - ii. Marks awarded by review committee : 10
        - iii. Quality of Project report : 05

2. Guidelines for Assessment of Mini Project Practical/Oral Examination:

- **a.** Report should be prepared as per the guidelines issued by the University of Mumbai.
- **b.** Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.

Students shall be motivated to present their mini project work done

1. Participate in Project Competition
2. Publish paper in Conferences/Journals.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction**	**8**
	1.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas. Characteristics and quality attributes (Design Metric) of embedded system.	
	1.2	Identification of Project Title	
2		**Controller boards and Programming – Embedded C**	**8**
	2.1	ARM LPC 21XX (2148), STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and **PIC/PSoc***	
	2.2	Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation , Arrays, Strings, Structure and unions, Classifier	
	2.3	**Exercise:** Identify the suitable board required for the particular application with respect to design metrics. (**Hint:** check clock frequency (speed) , memory (program and data), no. of ports for peripherals, timers/counters and serial communication requirement for project)	
	2.4	**Suggested Way to Identify :** https://predictabledesigns.com/how-to-select-the-microcontroller-for-your-new-product/	
3		**Interfacing Sensors and peripherals using Embedded C**	**10**
	3.1	Sensors and Signal Conditioning Circuits amplifiers /attenuators /filters /comparators/ADC and DAC) , Interfacing with GLCD/TFT display , Relays and Drivers for interfacing Motors (DC and stepper)	
	3.2	Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing	
	3.3	**Exercise :** Understand the Interfacing requirement like drivers, signal condition circuits for sensors, etc. for the selected application	
	3.4	**Study Material : For LCD interfacing with MSP430 LaunchPad** https://microcontrollerslab.com/lcd-interfacing-msp430-launchpad/#:~:text=LCD%20interfacing%20with%20MSP430%20microcontroller,Now%20I%20will&text=It%20requires%205%20volts%20dc,and%20second%20pin%20is%20vcc.	
4		**Communication with programming in Embedded C**	**10**
	4.1	Serial communication, CAN bus, I2C, MOD bus, SPI	
	4.2	Interfacing with Wi-Fi, Bluetooth ,ZigBee, LoRa, RFID and putting data on IoT	
	4.3	Interfacing with GSM module , GPS module, SD card	
	4.4	**Exercise:** Understand Communication requirement for selected application and test it	

	4.5	**Study Material :** Serial Communication Interface: **STM32:**https://controllerstech.com/serial-transmission-in-stm32/#:~:text=Serial%20Transmission%20in%20Stm32&text=UART%20is%20widely%20used%20for,amongst%20which%20communication%20is%20done. **LPC2148:** https://www.electronicwings.com/arm7/lpc2148-uart0 **MSP430:** https://www.ti.com/lit/ml/slap117/slap117.pdf	
5		**Real Time Operating Systems[RTOS]**	**08**
	5.1	Operating system basics , Types of OS , Tasks, process, Threads	
	5.2	Multiprocessing and ,Multitasking , Task scheduling	
	5.3	RTLinux/ Free RTOS and Mbed OS , Implementation with RTOS	
6		**Cloud/Web server**	**08**
	6.1	Implementation on web server ,	
	6.2	Thingspeak, AWS cloud platform for IoT based programming and modelling	
	6.3	**Exercise : perform ESP8266 interface with microcontroller**	
	6.4	**Study Material :** **STM32:** https://circuitdigest.com/microcontroller-projects/interfacing-esp8266-with-stm32f103c8-stm32-to-create-a-webserver **LPC2148:** https://circuitdigest.com/microcontroller-projects/iot-based-ARM7-LPC2148-webserver-to-control-an-led **MSP430:** https://circuitdigest.com/microcontroller-projects/sending-email-using-msp430-and-esp8266	
		Total	**52**

NOTE:

* **Advanced Microcontroller:** Like PSoc and PIC may be used as per the student's intellectual ability and strength.

** **Module 5 and 6 (RTOS and Cloud/Web Server):** Can be included by Guide /supervisor /Mentor depending upon need and scope of the project for selected topic and its application.

Textbooks:

1. Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
2. Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication.
3. Raj Kamal," Embedded Systems Architecture, Programming and design",Tata MCgraw-Hill Publication.
4. Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming",Dreamtech Publication.
5. Iyer, Gupta," Embedded real systems Programming", TMH
6. David Simon, "Embedded systems software primer',Pearson
7. Andrew Sloss, Dominic Symes and Chris Wright, "ARM_System_Developers_Guide-Designing_and_Optimizing_System_Software" Elsevier and Morgan Kaufmann Publishers.
8. Michel J Pont "Embedded C" Pearson

Suggested Software tools:

1. Tinkercad : https://www.tinkercad.com/
2. Proteus software
3. KEIL for ARM LPC 2148
4. **STM32Cube software**

5. MSP Flasher - Command Line Programmer
6. msp430 code composer studio

Online Repository:

1. https://circuitdigest.com
2. www. Github.com
3. https://www.electronicshub.org
4. https://www.hackster.io/

NPTEL Courses:

1. **Introduction to Embedded System Design (using MSP430)**
   https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2. **Embedded System Design with ARM**
   https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. **Embedded systems**
   https://nptel.ac.in/courses/108/102/108102045/
4. **Master Microcontroller and Embedded Driver Development(MCU1) STM32**
   https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver-development/?gclid=CjwKCAjw07qDBhBxEiwA6pPbHslLI-EqmAv7E17ysZETbreXe0XMb8Nai4NBqpUAvni5v-3fLKsfNBoC8LQQAvD_BwE&matchtype=b&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=udemyads&utm_source=adwords&utm_term=_._ag_82876601447_._ad_511749008336_._kw_%2Bembedded+%2Bsystems+%2Bcourse_._de_c_._dm__._pl__._ti_kwd-671751469914_._li_1007785_._pd__._
5. **Texas Instruments (TI) Trainings**
   https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2103/training-support
6. **Texas Instruments (TI) Teaching material/ text books**
   https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2035/textbooks

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC601	Electromagnetics and Antenna	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC601	Electromagnetics and Antenna	20	20	20	80	03	--	--	100

Pre-requisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective: The objective of the course is to make student familiar with Maxwell’s equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcome: Student will be able to:

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell’s equations.
2. Students will be able to apply Maxwell’s equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Static fields**	**06**
	1.1	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation	
	1.2	Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations	
	1.3	Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential	
2.0		**Electromagnetic Field and Maxwell's Equations**	**09**
	2.1	Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions.	
	2.2	EM wave propagation through lossy, perfect dielectric and conducting medium.	
	2.3	Power in EM Wave: Poynting theorem and Poynting vector	
3.0		**Basic of Antennas**	**08**
	3.1	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential	
	3.2	Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula	
	3.3	Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	
4.0		**Antenna Arrays**	**06**
	4.1	Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication	
	4.2	Introduction to Planner and circular arrays Introduction to array synthesis using Binomial array	
5.0		**Types of antennas**	**06**
	5.1	Yagi antenna, Broadband antenna like Helical and Log Periodic antenna Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn	
	5.2	Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector	
	5.3	Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)	
6.0		**Electromagnetic Wave Propagation**	**04**
	6.1	Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation	
		Total	**39**

Textbooks:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition
3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

Reference Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Computer Communication Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC602	Computer Communication Networks	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC: 405– Principles of communication engineering

ECC: 501-Digital communication

Course Objectives:

1. To introduce networking architecture and protocols.
2. To understand and recognize the layer-wise functions, services, data formats, protocols, hardware devices and addresses in the TCP/IP architecture
3. To build an understanding of application layer protocols.
4. To apply different addressing and routing schemes.

Course Outcomes:

After successful completion of the course student will be able to:

1. Analyze network topologies, hardware devices, addressing schemes and the protocol stacks
2. Compare various transmission media and broadband technologies
3. Analyze the flow control, error control and the medium access control techniques
4. Judge network layer addressing and routing schemes
5. Analyze connection oriented and connectionless services
6. Apply the knowledge of application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Network Architectures, Protocol Layers, and Service models**	**06**
	1.1	Applications of computer networks. Network types: LAN, MAN, and WAN, Network topologies.	
	1.2	Protocols and standards, need of layered protocol architecture, OSI reference model.	
	1.3	TCP/IP architecture: protocol suite, comparison of OSI and TCP/IP	
	1.4	Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison)	
	1.5	Addressing: physical / logical /port addressing/socket addressing.	
2.0		**Physical Layer**	**04**
	2.1	Guided transmission media: comparison among coaxial, optical fiber and twisted pair cables.	
	2.2	Unguided transmission media	
	2.3	Transmission impairments	
	2.4	Broadband standards: Cable modem, DSL, and HFC	
3.0		**Data Link Layer**	**07**
	3.1	Data link services: Framing, Flow control, Error control	
	3.2	ARQ methods: transmission efficiency, Piggybacking	
	3.3	High Level Data Link Control (HDLC): HDLC configurations, Frame formats, HDLC bit stuffing and de-stuffing, Typical frame exchanges.	
	3.4	Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.0		**Network Layer**	**12**
	4.1	Introduction to telephone networks and circuit switching principles.	
	4.2	Introduction to data networks and packet switching principles.	
	4.3	Network layer services and functions.	
	4.4	Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classful and classless (CIDR))	
	4.5	Routing in Packet Switching Networks: Characteristics, Routing strategies	
	4.6	Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF, BGP and EIGRP.	
	4.7	Subnetting, supernetting, VLSM, and NAT	
	4.8	Introduction to ICMP, ARP, RARP	
	4.9	IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6).	
	4.10	Quality of service	
5.0		**Transport Layer**	**06**
	5.1	Connectionless and Connection–oriented services at transport layer, Transmission Control Protocol (TCP): TCP Services, TCP Segment, TCP three way handshake	
	5.2	User datagram Protocol (UDP), UDP Services, UDP Datagram	
	5.3	TCP and UDP checksum calculation	
	5.4	Flow control, error control and congestion control	

6.0		**Application Layer**	**04**
	6.1	Introduction to Application layer Protocols: HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP.	
		Total	**39**

Text books:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013.
3. J J. F. Kurose and K. W. Ross,” Computer Networking: A Top-Down Approach”, Addison Wesley, 5th Edition, 2010

Reference books:

1. Alberto Leon Garcia, “Communication Networks”, McGraw Hill Education, Second Edition, Fourth Edition, 2008.
2. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education, 2015.
3. Understanding communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning
4. Data and Computer Communications, William Stallings, 10th Edition, Pearson Education, 2014.

Internal Assessment (IA):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.

3. Remaining questions will be mixed in nature and randomly selected from all the modules.

4.Total 04 questions need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC603	Digital Image Processing and Machine Vision	03	--	--	03	--	-	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC603	Digital Image Processing and Machine Vision	20	20	20	80	03	--	--	100

Prerequisites:

1. Signals and Systems
2. Discrete Time Signal Processing
3. Python Programming Skill Lab

Course Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations
3. To teach the students image morphology and restoration techniques
4. To expose the students to segmentation techniques in image processing and Machine Vision
5. To teach the techniques of extracting image attributes like regions and shapes
6. To learn classification and recognition algorithms for machine vision

Course Outcomes:

After successful completion of the course student will be able to

1. Understand fundamentals of image processing and machine vision
2. Enhance the quality of image using spatial and frequency domain techniques for image enhancement
3. Learn image morphology and restoration techniques
4. Learn image segmentation techniques based on principle of discontinuity and similarity using various algorithms
5. Represent boundaries and shapes using standard techniques.
6. Classify the object using different classification methods

Module No.	Unit No.	Topics	Hrs.
1	**DIGITAL IMAGE FUNDAMENTALS AND POINT PROCESSING**		**04**
	1.1	Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels	02
	1.2	**Point Processing :** Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification	02
2	**IMAGE ENHANCEMENT**		**08**
	2.1	**Spatial Domain filtering** : The Mechanics of Spatial Filtering, **Smoothing Spatial Filters**-Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal **Sharpening Spatial Filters-** The Laplacian, Unsharp Masking and Highboost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts	03
	2.2	**Frequency Domain Filtering:** Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform	02
	2.3	**Frequency Domain Filtering Fundamentals**, Fourier Spectrum and Phase angle ,Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth , Gaussian	03
3	**IMAGE MORPHOLOGY AND RESTORATION**		**06**
	3.1	**Morphology:** Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening	04
	3.2	**Restoration** : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	02
4	**IMAGE SEGMENTATION**		**08**
	4.1	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm , Edge linking : Local processing and boundary detection using regional processing (polygonal fitting)	05
	4.2	**Thresholding** : Foundation, Role of illumination and reflectance, Basic global thresholding	01
	4.3	**Region Based segmentation**: Region Growing, Region Splitting and merging	02
5	**INTRODUCTION TO MACHINE VISION AND DESCRIPTORS**		**05**
	5.1	Principle of machine vision , real world applications, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences	03
	5.2	Introduction to Texture, co-occurrence matrix	02
6	**MACHINE VISION ALGORITHMS**		**08**
	6.1	Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix	02
	6.2	K-means clustering algorithm, Introduction, bays decision theory continuous case, two category classification, Bayesian classifier ,Support vector machine	06
		TOTAL	**39**

Text Books:

1. Milan Sonka ,Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision” Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, “Digital Image Processing”, Pearson Education, India, Third Edition,
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Reference books:

1. Anil K.Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, 1989.
2. W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002
3. Forsyth and Ponce, Computer vision: A modern approach, PHI
4. Frank Y Shish ,Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Artificial Neural Networks and Fuzzy Logic	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC604	Artificial Neural Networks and Fuzzy Logic	20	20	20	80	03	--	--	100

Course Prerequisites:

1. Basic linear Algebra
2. Engineering Mathematics-I to IV

Course Objectives:

1. To introduce the concepts and understanding of artificial neural networks
2. To provide adequate knowledge about supervised and unsupervised neural networks
3. To introduce neural network design concepts
4. To expose neural networks based methods to solve real world complex problems
5. To study the architecture of CNN and its application in image classification.
6. To introduce fuzzy logic and fuzzy inference systems

Course Outcomes:

After successful completion of the course, the student will be able to:

1. Comprehend the concepts of biological neurons and artificial neurons
2. Analyze the feed-forward and feedback neural networks and their learning algorithms.
3. Comprehend the neural network training and design concepts
4. Build a simple CNN model and apply in image classification
5. Analyze the application of neural networks and fuzzy logic to real world problems.

Module No.	Topics	Hrs.
1.0	**Introduction to Neural Networks and their Basic Concepts**	**07**
	Biological neuron and Artificial neuron, McCulloch-Pitts Model, Activation Function, various types of Activation Functions and types of Neural Network Architectures, Prerequisites for Training of Neural Networks. Linearly Separable and Linearly Non-Separable Systems with examples, Concepts of Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Brief survey of applications of Neural Networks.	
2.0	**Supervised Learning Neural Networks**	**07**
	Perceptron - Single Layer Perceptron, Multilayer Perceptron and their Architecture. Error Functions: Mean Square Error and Sum Squared Error. Gradient Descent, Generalized delta rule, Error back propagation, Stopping Criterions for Training.	
3.0	**Unsupervised Learning Neural Networks**	**07**
	Competitive Learning Network – Kohonen Self-Organizing Networks – Architecture, Training Algorithm, Discrete Hopfield Network- Hopfield Matrix, Testing Algorithm, K-Means Clustering Algorithm.	
4.0	**Algorithms of Neural Networks**	**04**
	Basic concept of Machine Learning, Support Vector Machine (SVM) - Introduction and SVM based Binary Classifier, LMS Algorithm.	
5.0	**Convolution Neural Network (CNN)**	**07**
	Basic concept of Deep Learning, Convolution Operation, Overview of CNN Architecture, Input layer, Convolution layers, Pooling layers, Padding, Strided Convolutions, Rectified Linear Unit (ReLU), One Layer of a Convolutional Network, Fully Connected Layers, Complex Image Classification using CNN.	
6.0	**Introduction to Fuzzy Inference System**	**07**
	Introduction to Fuzzy Logic, Fuzzy Rules, Fuzzy Properties - Operations, Membership Functions, Fuzzification - Membership Value Assignments using Intuition Method, Defuzzification Methods -- Mean of Maxima and Centroid (Centre of Area) Methods, Fuzzy Inference System with reference to Mamdani Model, Brief Review of Applications of Fuzzy Logic to Speed Control of DC Motor and Washing Machine.	
	Total	**39**

Text Books:

1. S. N. Sivanandam and S. N. Deepa, Introduction to Soft Computing, Wiley India Publications, 3rd Edition.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson Prentice Hall, 3rd Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms, PHI Learning Pvt. Ltd, 2003.
4. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, Packt Publishing, 2018.
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India Publications, 3rd Edition.

References:

1. Hagan, Demuth, and Beale, Neural Network Design, Thomson Learning, 2nd Edition.
2. Simon Haykin, Neural Network- A Comprehensive Foundation, Pearson Education, 2nd Edition.
3. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2005.
4. William W. Hsieh, Machine Learning Methods in the Environmental Sciences: Neural Network and Kernels, Cambridge University Press, 2009.
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
6. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, Introduction to Neural Network using Matlab, Tata McGraw-Hill Publications, 2006.
7. Mehrotra Kishan, Mohan C. K. Ranka Sanjay, Elements of Artificial Neural Networks, Penram International Publishing Pvt. Ltd, 2nd Edition.
8. J. M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishers, 2006.
9. Bart Kosko, Neural Networks and Fuzzy Systems, Pearson Education, 2007.

Recommended NPTEL / Swayam Course and Online resources:

1. Course: Fuzzy Logic and Neural Networks by Prof. Dilip Kumar Pratihar, IIT Kharagpur
2. Course: Neural Network and Applications by Prof. Somnath Sengupta, IIT Kharagpur
3. Michael Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015. http://neuralnetworksanddeeplearning.com/

List of Suggested Experiments to be conducted in IPMV Laboratory (ECL 603):

1. **Classification of Non-linearly Separable Binary Pattern using Multilayer Perceptron Neural Network.**
2. **Pattern Clustering using K-means Algorithm.**
3. **Binary Pattern Restoration using Discrete Hopfield Neural Network.**
4. **Image Classification using Support Vector Machine.**
5. **Object Recognition using Convolutional Neural Network.**
6. **Design Fuzzy Controller for Washing Machine**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed, and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6011	Mixed Signal VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6011	Mixed Signal Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits
ECC303 –Digital System Design
ECC403 – Linear Integrated Circuits
ECC503 – Digital VLSI

Course Objectives:

1. To know importance of Mixed Signal VLSI design in the field of Electronics and Telecommunication and emerging technologies.
2. To understand various methodologies for analysis and design of fundamental CMOS analog and mixed signal Circuits.
3. To learn various issues associated with high performance Mixed Signal VLSI Circuits
4. To design, implement and verify various mixed signal VLSI circuits using open source tools like Ngspice and Magic.

Course Outcomes:

After successful completion of the course student will be able to:

1. Know operation of the various building blocks of analog and mixed signal VLSI circuits.
2. Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits.
3. Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit.
4. Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
5. Evaluate and select appropriate circuit/configuration for given application.
6. Design analog and mixed signal VLSI circuits for given application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Integrated Circuit Biasing Techniques**	**06**
	1.1	Active resistance, current source, current sink, simple current mirror, cascode current mirror	03
	1.2	Current and voltage references, Band gap reference generator	03
2.0		**Single Stage MOS Amplifiers**	**08**
	2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, simulation of CMOS amplifiers using SPICE	04
	2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	04
3.0		**Noise in MOS Circuits**	**06**
	3.1	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise	02
	3.2	Representation of noise in circuits, noise in single stage CS, CD and CG amplifier	02
	3.3	Noise in differential pairs, noise bandwidth	02
4.0		**CMOS Operational Amplifier**	**05**
	4.1	Design of Current Mirror Load Differential Amplifier	02
	4.2	Design of two stage Operational Transconductance Amplifier, OpAmp Compensation techniques	03
5.0		**Data Converter Fundamentals**	**06**
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics	03
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations	03
6.0		**Data Converter Architectures**	**08**
	6.1	DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC	04
	6.2	ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC	04
		Total	**39**

Text Books:

1. B. Razavi, **"***Design of Analog CMOS Integrated Circuits***"**, first edition, McGraw Hill,2001.
2. P.E.Allen and D R Holberg, **"***CMOS Analog Circuit Design***"**, second edition, Oxford University Press, 2002.
3. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

Reference Books:

1. Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, "Microelectronics Circuits Theory and Applications", Fifth Edition, Oxford University Press.
2. Gray, Meyer, Lewis and Hurst **"***Analysis and design of Analog Integrated Circuits***"**, 4th Edition Willey International, 2002
3. Tony Chan Carusone, David Johns, Kenneth Martin, " Analog Circuit Design", Second Edition, Wiely

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/117/101/117101105/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6012	**Computer Organisation and Architecture**	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECCDLO 6012	**Computer Organisation and Architecture**	20	20	20	80	03	--	--	100

Course Pre-requisites:

ECC303-Digital System Design

ECC402-Microcontrollers

Course objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To understand memory systems, processor organization and generation of control unit signals.
3. To demonstrate the operation of various arithmetic algorithm including integer and floating point representation.
4. To understand the working principles of multiprocessor and parallel organization’s as advanced computer architectures.

Course outcomes:

After successful completion of the course student will be able to -

1. Describe Computer system along with I/O operations and performance measures.
2. Demonstrate data representation and different arithmetic algorithm for solving ALU operations.
3. Categorize memory organization and identify the function of each element of memory hierarchy.
4. Demonstrate control unit operations.
5. Articulate design issues in the development of Multiprocessor organization & architecture

Module No.	Unit No.	Topics	Hrs
1		**Computer Organization, Architecture and Performance**	8
	1.1	Organization and Architecture,	
	1.2	Structure and Function,	
	1.3	Designing for Performance,	
	1.4	Multicore, MICs, and GPGPUs	
	1.5	Two Laws that Provide Insight: Amdahl’s Law and Little’s Law	
	1.6	Basic Measures of Computer Performance,	
	1.7	Calculating the Mean	
	1.8	Benchmarks and SPEC	
2		**Computer System**	6
	2.1	Computer Components	
	2.2	Computer Function	
	2.3	Interconnection Structures	
	2.4	Bus Interconnection	
3		**Data Representation and Arithmetic Algorithms**	5
	3.1	Unsigned & Signed multiplication- Add & Shift Method, Booth’s algorithm. Unsigned & Signed division, Restoring and non-restoring division.	
	3.2	Integer and floating point representation, IEEE 754 standard for floating point (Single & double precision) number representation.	
4		**Memory System Organization**	7
	4.1	Classification and design parameters, Memory Hierarchy ,Internal Memory: RAM, SRAM and DRAM	
	4.2	Cache Memory: Characteristics of Memory Systems, Cache Memory Principles, Elements of Cache, Cache Coherence. Design problems based on mapping techniques	
	4.3	Virtual Memory, External Memory : Magnetic Discs, Solid State Drive, Optical Memory, Flash Memories, RAID Levels	
5		**Control Unit Design**	8
	5.1	Micro- Operations: The Fetch Cycle, The Indirect Cycle, The Interrupt Cycle, The Execute cycle, The Instruction Cycle	
	5.2	Control of the Processor: Functional Requirements, Control Signals, Internal Processor Organization	
	5.3	Hardwired Control Unit	
	5.4	Microinstructions Microprogrammed Control Unit, Advantages & disadvantages	
6		**Fundamentals of Advanced Computer Architecture**	5
	6.1	Parallel Architecture: Classification of Parallel Systems,	
	6.2	Flynn’s Taxonomy, Array Processors, Clusters, and NUMA Computers	
	6.3	Multiprocessor Systems : Structure & Interconnection Networks	
	6.4	Multi-Core Computers: Introduction, Organization and Performance.	
		Total	**39**

Text Books:

1. William Stallings “Computer Organization and Architecture Designing for Performance” Tenth Edition, Pearson Education.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGrawHill,
3. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition

Reference books:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design -
2. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007
3. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998
4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6013	Digital Forensic	3	--	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6013	Digital Forensic	20	20	20	80	03	--	--	100

Course prerequisite:

ECC602: Computer Communication Networks

Course Objectives:

1. To understand cyber attacks and various categories of Cybercrime.
2. To discuss the need and process of digital forensics and Incident Response Methodology.
3. To explore the procedures for identification, preservation, and extraction of digital evidence.
4. To explore techniques and tools used in digital forensics for system investigation.
5. To discuss the investigation process of network and host based system intrusions.
6. To understand the laws related to Cybercrime

Course Outcomes:

On successful completion of the course, students will be able to

1. Study the various cybercrimes and its prevention methods.
2. Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
3. Understand the process of collection, analysis and recovery of the digital evidence.
4. Explore various tools to perform the investigation of the crime scenario.
5. Investigate the process of monitoring and analysis of computer network traffic for network investigation.
6. Discuss the legal issues associated with the cyber laws.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Cybercrime and Hacking**	**08**
	1.1	Cybercrime, Categories of Cybercrime (Cybercrime against people, Cybercrime Against property, Cybercrime Against Government), Types of cybercrime (Violent- Cyber terrorism, Assault by Threat, Cyberstalking, Child Pornography, Non-violent - Cybertrespass, Cyber Theft, Cyberfraud, Destructive Cybercrimes), Computers' role in crimes	
	1.2	Hacking, Life cycle of Hacking, Types of Hackers (White Hat hackers, Black Hat hackers, Grey Hat hackers), Hacking techniques, Passive and Active Attacks, Social Engineering, Attacks vs Vulnerabilities, Prevention of Cybercrime	
		Self-learning topics: Distinction between computer crimes and conventional crimes.	
2.0		**Introduction to Digital Forensics**	**07**
	2.1	Objectives of digital forensics, Process of digital forensics, Types of digital forensics, Challenges faced by digital forensics	
	2.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
		Self-learning topics: Distinction between Computer virus, worm, Trojan horse and trap door.	
3.0		**Digital Evidence and Forensics Duplication**	**07**
	3.1	Digital evidence, Admissibility of evidence, Challenges in evidence handling, collecting digital evidence, Preserving digital evidence, Documenting evidence	
	3.2	Necessity of forensic duplication, Forensic duplicates as admissible evidence, Forensic image formats, Forensic duplication techniques, Disk imaging, Analysis of forensic images using FTK Imager	
		Self-learning topics: Digital Evidence Investigation using Autopsy	
4.0		**System Investigation**	**08**
	4.1	Live/volatile data collection from Windows and Unix Systems	
	4.2	Investigating Windows systems, Investigating UNIX systems, Investigating applications, Web browsers, Email tracing	
	4.3	Recovering digital evidence, Acquiring, Analyzing and duplicating data: dd, dcfldd, foremost, scalpel	
		Self-learning topics: Methods of storing data (RAM and Hard disk)	
5.0		**Network Forensics**	**05**
	5.1	Introduction to intrusion detection systems, Types of IDS, Understanding network intrusion and attacks	
	5.2	Analyzing network traffic, collecting network based evidence, Evidence handling. Investigating routers	
		Self-learning topics: Use of packet sniffing tools like Wireshark	
6.0		**Laws related to cyber crime**	**04**
		Constitutional law, Criminal law, Civil law, Levels of law: Local laws, State laws, Federal laws, International laws. Levels of culpability: Intent, Knowledge, Recklessness, Negligence. CFAA, DMCA, CAN Spam	
		Self-learning topics: Relevant law to combat computer crime –Information Technology Act	
		Total	**39**

Text books

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. “Scene of the Cybercrime: Computer Forensics” Handbook 1st Edition, Kindle Edition
3. “Digital Forensics”, Nilakshi Jain & Kalbande, Wiley Publication
4. “Cyber Security”, Nina Godbole, Sunit Belapure, Wiley Publication

Reference books

1. Bill Nelson,Amelia Phillips,Christopher Steuart, “Guide to Computer Forensics and Investigations” . Cengage Learning, 2014
2. Debra Littlejohn Shinder Michael Cross “Scene of the Cybercrime: Computer Forensics Handbook”, 2nd Edition Syngress Publishing, Inc.2008.
3. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Suggested MOOCs for Self-Learning:

1. Course on “Ethical Hacking”
   https://nptel.ac.in/courses/106/105/106105217/
2. Course on “Digital Forensics”
   https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3. Course on “Computer Forensics”
   https://www.edx.org/course/computer-forensics
4. Course on Cyber Incident Response
   https://www.coursera.org/learn/incident-response
5. Course on “Penetration Testing, Incident Responses and Forensics”
   https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6014	Database Management System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6014	Database Management System	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC 205 : C Programming
ECL 304 : Skill Lab :- C++ and Java Programming
ECL 405 : Skill Lab :- Python Programming

Course Objectives:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4. Understand the concept of database security and privacy

Course Outcome:

After successful completion of the course student will be able to

1. Describe the fundamentals of database systems, different data models and design issues in database.
2. Understand the basics model of relational Algebra, calculus, transaction management, concurrency control , database security and privacy
3. Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4. Implement views, triggers and querying the database using SQL.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Databases**	**02**
	1.1	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, Three tier database architecture, Data independence	
2.0		**Data Models**	**03**
	2.1	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	
3.0		**Database Design, ER-Diagram and Unified Modeling Language**	**08**
	3.1	Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets	
	3.2	Codd‘s rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	
4.0		**Relational Algebra and Calculus**	**09**
	4.1	Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics.	
	4.2	Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	
	4.3	Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	
5.0		**Constraints, Views and SQL**	**10**
	5.1	What is constraints, types of constrains, Integrity constraints,	
	5.2	SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	
	5.3	Views: Introduction to views, data independence, security, updates on views, comparison between tables and views	
	5.4	** SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	
6.0		**Transaction management and Concurrency control**	**07**
	6.1	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	
	6.2	Database Security and privacy : Issues, Access Control based on grant and revoke privileges	
		Total	**39**

**** Teacher can select any one SQL Tool for implementation of SQL query**

Textbooks:

1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts‖", Fifth Edition McGraw-Hill
2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System‖", Seventh Edition, Person.
4. G. K. Gupta, "Database Management Systems‖", McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
5. Debabrata Sahoo "Database Management Systems‖ Tata McGraw Hill, Schaum's Outline

E-Resources:

1. https://www.w3schools.in/dbms/
2. https://www.tutorialspoint.com/dbms/index.htm
3. https://www.studytonight.com/dbms/

Self-Learning: Suggested Case Studies (Any such cases can be selected by Teacher)

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Students Database Management System
6. Employee Management System
7. Inventory Control Management database

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6015	IoT and Industry 4.0	3	-	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work Oral	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6015	IoT and Industry 4.0	20	20	20	80	03	--	--	100

Course pre-requisite:
ECM401: Mini Project – 1 B
ECC402: Microcontrollers
ECL404: Skill based Lab Course
ECM501: Mini Project 2A Embedded System Project

Course Objectives:

1. To offer introduction to Internet of Things and industry 4.0 standard
2. To understand the design features of Internet of Things (IoT)
3. To understand concepts of data management and data analytics in IoT
4. To understand the concept and framework of industry 4.0 standard
5. To understand the application of IoT and Industry 4.0 standard.

Course Outcome:

On successful completion of the course the students will be able to:

1. Discuss case studies and use cases of IoT design.
2. Illustrate various protocols of web connectivity.
3. Understand and use tools for data management and analytics in IoT.
4. Explain various frameworks for industry 4.0 standards.
5. Prepare case studies on applications of IIOT.
6. Understand advanced concepts and applications of industry 4.0

Module No.	Unit No.	Topics	Hrs.
1		**Introduction to IoT**	**04**
	1.1	**Introduction -** Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, **IoT and M2M -** IoT/M2M System layers and Design standardization, Difference between IoT and M2M	
	1.2	**Defining Specifications About -** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study	
2		**Network & Communication aspects**	**08**
	2.1	**Design Principles & Web Connectivity -** Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish —Subscribe), MQTT, AMQP, CoAP Protocols	
	2.2	**Internet Connectivity: -** Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE Ml, SIGFOX, Case Study	
3		**Data Management and Analytics for IoT**	**08**
	3.1	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, ApacheStorm, Using Apache Storm for Real-time Data Analysis	
	3.2	Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator	
4.0		**Introduction to Industry 4.0**	**08**
	4.1	Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT-Layers, Sensing, Processing, Communication.	
	4.2	Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	
5.0		**Introduction to Industrial IoT (IIoT)**	**06**
	5.1	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management.	
	5.2	Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	
6.0		**Industry 4.0 Technologies and Applications**	**05**
	6.1	Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Provacy Concerns	
	6.2	Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	
Total			**39**

Text books:

1. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, “ Internet of Things: Architecture and Design Principles”, McGraw Hill Education ,First edition
3. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications,
4. Andrew Minteer ,”Analytics for the Internet of Things(IoT)”,Kindle Edition
5. Giacomo Veneri , Antonio Capasso,” Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0”, Packt

Suggested reference material (research papers):

1. https://www.mdpi.com/2071-1050/11/16/4371/pdf- Industry 5.0—A Human-Centric Solution – MDPI (open access)
2. https://www.researchgate.net/profile/Mary-Doyle-Kent/publication/336819748_Industry_50_Is_the_Manufacturing_Industry_on_the_Cusp_of_a_New_Revolution/links/5e84b810a6fdcca789e5ff75/Industry-50-Is-the-Manufacturing-Industry-on-the-Cusp-of-a-New-Revolution.pdf - Industry 5.0: Is the Manufacturing Industry on the Cusp of a New Revolution?

Reference books

1. Alp Ustundag Emre Cevikcan,” Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing
3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
4. The Internet of Things (MIT Press) by Samuel Greengard
5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things”, Paperback,First Edition

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4. https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design
5. By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools for self learning:

1. Node Red - https://nodered.org/
2. M2MLabs Mainspring - http://www.m2mlabs.com/
3. Tensor Flow - https://www.tensorflow.org/
4. Things Speak - https://thingspeak.com/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6016	Radar Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6016	Radar Engineering	20	20	20	80	03	--	--	100

Pre requisites:

ECC405 - Principles of Communication Engineering

Course objectives:

1. To interpret Radar equations
2. To explain different types of radar
3. To introduce RADAR transmitters and receivers for given conditions
4. To understand/ implement the plotting for given RADAR target

Course outcomes:

After successful completion of the course student will be able to

1. Explain generalized concept of RADAR.
2. Solve problems using radar equations.
3. Describe different types of radar for specific application.
4. Explain concept of tracking radar.
5. Plot the RADAR target from given specification.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Radar and Radar Equation**	**08**
	1.1	Basics Radar, Radar equation, Block Diagram, Radar Frequencies	
	1.2	Detection of signal in noise, Receiver Noise and Signal-to-noise Ratio	
	1.3	Probability of detection and false alarm: Simple, complex Targets, Pulse Repetition Fr	
2.0		**MTI and Pulse Doppler Radar**	**08**
	2.1	Introduction to Doppler and MTI radar, Doppler frequency shift	
	2.2	Simple CW Doppler radar, MTI radar block diagram	
	2.3	Delay line canceler	
	2.4	Moving-target-detection	
	2.5	Pulse Doppler radar	
3.0		**Tracking Radar**	**06**
	3.1	Monopulse tracking	
	3.2	Conical scan and sequential lobbing	
	3.3	Limitation of tracking accuracy , Low angle tracking	
4.0		**Radar Transmitters and Receviers**	**06**
	4.1	Radar RF power sources: Klystron	
	4.2	Travelling wave tube	
	4.3	Magnetron	
	4.4	Radar Receiver: Superheterodyne Receiver	
5.0		**Radar Clutters and landing system**	**06**
	5.1	Types of clutter : surface clutter, sea clutter, land clutter	
	5.2	Instrument landing system	
	5.3	Ground controlled approach, Microwave landing system	
	5.4	Radar altimeter	
6.0		**General ideas on RADAR plotting**	**05**
	6.1	Radar plotting -general ideas	
	6.2	Relative plotting (passive derivations), Relative plotting (action taken by target)	
	6.3	Radar Display: Types of displays	
		Total	**39**

Text Books:

1. Merill Skolnik,—Introduction to RADAR Systems,Tata McGrawHill, Third Edition
2. Merill Skolnik,—RadarHandbook, TataMcgrawHill, Second Edition
3. Dr. A. K. Sen, Dr. A. B. Bhattacharya- Radar Systems and Radio Aids to Navigation Khanna Publishers

Reference books:

1. Mark A.Richards,James A.Scheer, William A.Holm, —Principles of Modern Radar Basic Principals‖, ScitechPublishing.
2. SimonKingsley,ShaunQuegon,—UnderstandingRadarSystems‖,ScientechPublishing Inc.
3. G.S. N.Raju, —Radar Engineering and Fundamentals of Navigational Aids‖, I. K International publishing House Pvt.Ltd.
4. Dr. Arjun Singh -Radar Systems and Radio Aids to Navigation,McGraw-Hill Education Private Limited
5. CAPT. H. SUBRAMANIAM- Shipborne Radar And Arpa Nutshell Series Book3

Online Resource:

1. NPTEL online Course: https://nptel.ac.in/courses/108/105/108105154/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ECL601	Electromagnetics and Antenna Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. of Test 1 and Test 2				
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	25	25	50

Prerequisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective:

The objective of the course is to make student familiar with Maxwell’s equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcomes:

After successful completion of the course student will be able to

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell’s equations.
2. Students will be able to apply Maxwell’s equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

SUGGESTED LIST OF EXPERIMENTS

Sr. No.	NAME OF EXPERIMENTS
1.	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)
2.	Introduction to Different Antenna Types
3.	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)
4.	Study of Directive antenna, Yagi-Uda Antenna
5.	Study of Broad-band Antenna, Log-periodic Antenna
6.	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)
7.	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)
8.	Study of Regular shaped Microstrip Antenna
9.	Small Project report can be considered as a part of term-work (Design, Simulation and validation).
10.	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the ― Laboratory session batch wise".

Computation/ simulation-based experiments are also encouraged. The experiments should be students centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini project can be conducted for maximum batch of four students.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ECL602	Computer Communication Network Laboratory	-	02	-	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				**Term Work**	**Practical and Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test 1	**Test 2**	**Avg. of Test 1 and Test 2**				
ECL602	Computer Communication Network Laboratory	--	--	--	--	25	25	50

Lab Course Outcomes: -

Upon completion of the computer communication networks lab, the students will be able to:

- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer‘s specific needs.
- Perform configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications.
- Simulate computer networks and analyze the simulation results.
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Laboratory plan

Minimum of 8 practicals should be conducted and a mini project.

Suggested list of experiments:

1. To study basic networking commands. (Linux/Netkit)
2. To prepare a patch cable (straight-through, crossover, rollover) using UTP, RJ-45 and crimping tool. Test the cable using a cable tester and use it in LAN.
3. To configure and compare different network topologies using Cisco Packet Tracer
4. To study and compare network hardware components using Cisco Packet Tracer
5. To configure static routes in a network using Cisco Packet Tracer.
6. To configure a network with Distance Vector Routing Protocol-RIP using Cisco Packet Tracer and check the updated routing tables.
7. To configure a network with Path Vector Routing Protocol- BGP using Cisco Packet Tracer and check the updated routing tables.

8. To configure a network with Link state Routing Protocol- OSPF using Cisco Packet Tracer and check the updated routing tables.
9. To configure a network with Hybrid Routing Protocol- EIGRP using Cisco Packet Tracer and check the updated routing tables.
10. To perform subnetting using Cisco Packet Tracer/Netkit
11. To install a network simulator (NS2.35), create a wired network and compare the performance of TCP and UDP **or** Compare TCP and UDP performance using Netsim
12. To Simulate and study stop and Wait protocol using NS 2.35/ C++
13. To Simulate Sliding Window protocol using NS 2.35/C++
14. To Simulate and study the implementation of TCP/IP stack using wireshark (observe the protocols, data formats, header structures, addresses, payload sizes and encapsulation at each layer)
15. To perform HDLC bit stuffing and de-stuffing using C++
16. To configure DNS, DHCP, TELNET, FTP, SMTP server (any one) on Cisco Packet Tracer
17. To compare performance of ALOHA and Slotted ALOHA using Netsim.

Term Work: At **least 08 Experiments** covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented **one mini-project** can be conducted for a batch of maximum four students.

Term work assessment must be based on the overall performance of the student with every experiment and assignment graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Termwork marks distribution: Journal and practical Performance: 15 marks

Attendance: 5 marks

Assignment: 5 marks

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL603	Image Processing and Machine Vision Laboratory	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg.				
ECL603	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	50

Prerequisites:

1. Python Programming Skill Lab

Course Objectives:

1. To teach implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2. To give an exposure to students to object recognition/ classification techniques in Machine Vision.
3. To facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application.

Course Outcomes:

After successful completion of the course student will be able to

1. perform enhancement of digital images in spatial and frequency domain
2. perform edge detection and morphological operations on digital images
3. classify patterns using standard Machine vision classification techniques like SVM
4. apply theoretical knowledge in image processing and machine vision to practical case studies

SUGGESTED LIST OF EXPERIMENTS

1. Eight experiments covering the whole syllabus with proportional weightage to Image Processing and Machine Vision, to be set with predefined and concrete objective problem statement.
2. At least 5 programs to be conducted in python programming
3. At least 1 case study from suggested ones to be conducted in lab.
4. An attempt should be made to make experiments more meaningful, interesting and innovative.
5. Conduct three experiment based on application of **Neural Network and Fuzzy logic** for Image Processing.

Sr. No.	NAME OF EXPERIMENTS
1.	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing
2.	Histogram calculation and equalization
3.	Spatial Domain Filtering: 1. Smoothening filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering 4. Edge detection using 1st and 2nd order derivatives
4.	Frequency Domain Filtering : Ideal, Butterworth and Gaussian
5.	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction
6.	Image segmentation using global Thresholding Algorithm
7.	Shape representation using chain code
8.	Canny edge detection
9.	Feature extraction using co-occurrence matrix
10.	Classification using k-means algorithm
11.	Classification using Basiyan classifier
12.	Basic binary classification of any data or pattern using Support Vector Machine.
13.	Case Study : 1. Face recognition 2. Finger print identification 3. License plate recognition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	--	--	--	25	25	50

Course pre-requisite:
FEL204__C-Programming

Course Objectives:
1. Install Linux and implement standard Linux commands
2. Study basic theory of Linux Operating System
3. Implement the system administrative functionality
4. To write shell script programs to solve problems
5. Study basic commands of networking
6. Develop implementation skill of different servers on Linux

Course Outcome:
After successful completion of the course student will be able to :-
1. Install Linux using different platform and execute standard Linux commands.
2. Describe the basic knowledge of Linux Operating System
3. Deploy the system administrative functionality
4. Solve the problems using shell script programming
5. Develop network based applications
6. Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of Linux**	**08**
	1.1	Installing Software on Debian Based Linux: Debian, Ubuntu, Kali Linux	
	1.2	Overview of Unix and Linux architectures, Linux files system, Linux standard directories, Linux Directory Structure, Basic Linux Commands, Linux Networking commands, Viewing Files and the Nano Editor, Editing Files in Vi, Graphical Editors, Deleting, Copying, Moving, and Renaming Files	
2.0		**Linux OS**	**06**
	2.1	Linux Design Principles, Linux Booting Process, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output, Inter-process Communication.	
3.0		**System Administration**	**08**
	3.1	Common administrative tasks, Configuration and log files, Role of system administrator, Managing user accounts –adding, deleting users, Changing permissions and ownerships, Creating and managing groups, Modifying group attributes.	
	3.2	Temporary disabling of users accounts, Creating and mounting file system, becoming super user using su, Getting system information with uname, host name. Disk partitions & sizes, users, kernel, installing and removing packages, rpm command	
4.0		**Shell programming**	**12**
	4.1	Basics of shell programming, various types of shell available in Linux, Shell programming in bash, Conditional statements, Looping statements, Case statements, Parameter passing and arguments	
	4.2	System shell variables, Shell variables, shell keywords, Creating Shell programs for automating system tasks, Scheduling repetitive jobs using cron.	
5.0		**Linux Networking**	**08**
	5.1	Basics of Network Management, Setting up Dynamic and Static Addressing, Monitoring network services, Talking with DNS Servers, Remote System Administration with OpenSSH-Server & Putty.	
	5.2	TCP/IP Networking for Linux System Administrators, DNS and hostnames, DHCP, , Network Troubleshooting.	
6.0		**Servers and Configurations**	**10**
	6.1	Create and configure DHCP, Mail, DNS, FTP, Squid, Apache, Telnet, Samba servers	
		Total	**52**

Suggested List of Experiments:

Sr.	Title
1	Linux Installation process using following method CD-ROM, Network Installation or Kickstart Installation.
2	Basic commands to create users, change permission, software selection and installation and do changes in Grub file.
3	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.
4	Write a shell script to show various system configuration like currently logged user and his logname, your current shell, home directory, operating system type, current path setting, current working directory, show currently logged number of users, show memory information, Hard disk information like size of hard-disk, cache memory, model etc, and file system mounted.
5	Write a shell script to add user and password on Linux system.
6	Write a shell script to print last login details.

7	Write a shell script to upgrade and cleans the system automatically instead of doing it manually.
8	Write a shell script to delete all log files present inside your var/log directory.
9	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.
10	Write a awk script to find the number of characters, words and lines in a file?
11	Write a shell script that delete all lines containing a specified word
12	write a shell script to find the factorial of given integer
13	Configuration of DHCP Server and Client
14	Configuration of DNS Server with Domain Name.
15	Configuration of NFS File server and transfer files to a windows client.
16	Setting up a Samba Server and creating a print server.
17	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy.
18	Configuration of Mail Server
19	Configuration of Web Server.
20	Configuration of FTP server and transfer files to demonstrate the working of the same.

Text books:

1. YeswantKanethkar – “UNIX Shell Programming”, First edition, BPB.

2. Cristopher Negus – “Red Hat Linux Bible”, Wiley Dreamtech India 2005 edition..

3. Jason Cannon ,”Linux for Beginners: An Introduction to the Linux Operating System and Command line”

4. W. Stevens , Stephen Rago , “Advanced Programming in the UNIX Environment”, Addison-Wesley Professional Computing Series

Reference books:

1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India

2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.

3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dreamtech India.

4. Richard Petersen, Linux: The Complete Reference, Sixth Edition

Software Tools:
1. Install Ubuntu desktop | Ubuntu
2. Chapter 4. Quick Installation Guide Red Hat Enterprise Linux 7 | Red Hat Customer Portal
3. Installation | Kali Linux Documentation

Online Repository:
1. How to Install a DHCP Server in Ubuntu and Debian (tecmint.com)
2. How to Install and Configure Postfix as a Send-Only SMTP Server on Ubuntu 16.04 | DigitalOcean
3. Network - DHCP | Ubuntu

Term Work: At least **12 experiments** covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality. The experiments should be students centric as well as real time and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "Choice Based Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. **The practical and oral examination will be based on entire syllabus.** Students are encourages to share their experiments codes on online repository. **Practical exam should cover all 12 experiments for examination.**

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM601	Mini Project 2B: FPGA based Project	--	04$	--	--	2	--	2

$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM601	Mini Project 2B: FPGA based Project	--	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC303 - Digital Design
2. ECM401- Mini Project 1B
3. ECC503- Digital VLSI

Course Objectives :-

1. To train students for FPGA based project implementation and management
2. To make students VLSI industry ready
3. To make students familiar with the Verilog Programming
4. To make students familiar with the targeted FPGA design and implementation
5. To familiarize students with the numerous FPGA solutions available in Market
6. To familiarize the students with the Interfacing of FPGA boards

Course outcomes :

1. Understand various FPGA families and method of FPGA synthesis and implementation
2. Learn the working of basic EDA tools like Xilinx, Modelsim cadence , etc
3. Able to program, simulate and synthesize circuits in Verilog HDL.
4. Learn the technique of interfacing of LED, switches and seven segment with FPGA.
5. Learn the project documentation, designing and handling techniques
6. Analysis of FPAG fault detection and verification principles

1. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects. Students should do survey of FPGA boards, tools and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/ internal committee of faculties.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
3. A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/comments.
4. Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.
6. **Suggested steps for mini project selection and implementation**
    i. Mini project should be completely FPGA based
    ii. Follow these steps
        1. Take specification, using these specifications design project.
        2. Select proper FPGA considering features and requirements of project. Create UCF file
        3. Program it using Verilog and write test benches for verification of each module
        4. Test Functional Simulation and verify it using simulation tool
        5. Synthesize, map and place and rout the design using synthesis tool
        6. Generate bit stream and download on FPGA
        7. Verify results on FPGA hardware/hardware setup made for project

2. **Project Topic selection and approval :-**
    1. The group may be of maximum **FOUR (04)** students.
    2. Topic selection and approval by **2 Expert** faculty from department at the start of semester
    3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.
3. **Project Report Format:**
    1. Report should not exceed **15 pages**. Simply staple it to discourage use of plastic.
    2. The recommended report format is in LaTeX.

Term Work:

1. **Term Work evaluation and marking scheme:**
    a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
    b. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
    c. At end of semester the above 2 expert faculty who have approved the topic will internally **evaluate the performance**.
    d. Students have to give presentation and demonstration on the FPGA Based Mini Project- 2-B
    e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.
    f. **Distribution of 25 Marks scheme is as follows:**
        i. Marks awarded by guide/supervisor based on log book : 10
        ii. Marks awarded by review committee : 10
        iii. Quality of Project report : 05
2. **Guidelines for Assessment of Mini Project Practical/Oral Examination:**
    a. Report should be prepared as per the guidelines issued by the University of Mumbai.
    b. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.
    c. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to FPGA and Synthesis**	**04**
	1.1	Compare FPGA, ASIC, SOC, Basic FPGA architecture, Compare various FPGA Boards**, Understanding VLSI Design flow	
	1.2	**Understanding Tools :** Functional simulation , Synthesis and implementation, Synthesis tool flow, Implementation and bit generation, making User constraint files (UCF)	
	1.3	**Study Material** : https://www.xilinx.com/support/university/ise/ise-workshops/ise-fpga-design-flow.html	
2.0		**Writing First program in Verilog**	**04**
	2.1	**Introduction to Verilog**: Module definition, port declaration, connecting ports, Writing first Testbench	
	2.2	**Exercise :** Program for All gates, Writing Test bench and UCF	
	2.3	**Study Material**: https://www.xilinx.com/support/university/ise/ise-teaching-material/hdl-design.html	
3.0		**Combinational design Using VERILOG**	**08**
	3.1	Gate Level Modelling, hierarchical name referencing, **Data Flow Modelling**: Continuous assignments, delay specification, expressions, operators, operands, operator types	
	3.2	**Exercise:** Programming and FPGA implementation of Adders, 4-bit adders, Mux and decoders, **Interfacing** LED, switches with FPGA	
	3.3	**Study Material :** https://onlinecourses.nptel.ac.in/noc20_cs63/preview	
4.0		**Sequential design Using VERILOG**	**08**
	4.1	**Behavioral Modelling :** Structured procedures, initial and always, blocking ‘and non-blocking statements, delay control, event control, conditional statements, multi way branching, loops, sequential and parallel blocks **Advanced topics:** Tasks and Functions, generic programming with parameters.	
	4.1	**Exercise:** Programming and FPGA implementation of Counters FFs and Shift registers Interfacing Seven Segment Display, UART with FPGA	
5.0		**Project Outline**	**08**
	5.1	Clocked Synchronous State-Machine Analysis, State-Machine Structure, Output Logic, Characteristic Equations Analysis of State Machines with D Flip-Flops, Clocked Synchronous State-Machine Design, Designing State Machines Using State Diagrams, State Tables	
	5.2	**Project Design Steps**: Designing state diagram, block diagram of project, Selection of FPGA for project, Selection of synthesis and simulation tool.	
6.0		**Project Implementation and management**	**20**
	6.1	Git Repositories, Learning of Project management software’s like CVS, SVN etc	
	6.2	Project Implementation: Verilog coding, simulation, Synthesis, Bit generation and downloading on FPGA. .	
	6.3	Result verification and testing	
		Total	**52**

Reference books:

1. Samir Palnitkar, “Verilog HDL A guide to Digital Design and Synthesis” , 2nd Edition, Pearson Education, 2009
2. Simon D Monk, “Programming FPGAs : Getting started with Verilog”, 1st Edition, McGraw Hill Eduction-2016
3. M. Morris Mano, Michael D. Ciletti , “Digital Design: With a Introduction to the Verilog Hdl”, Pearson Prentice Hall, 2013
4. David Romano, “Make: FPGAs: Turning Software into Hardware with Eight Fun and Easy DIY”, Shroff/Maker Media; First edition,2016
5. Frank Vahid, “Digital Design”, Wiley India Private Limited; Preview edition, 2009
6. Behrooz Parhami ,“COMPUTER ARITHMETIC Algorithms and Hardware Designs”, , Oxford University Press, 2010
7. Clive Maxfield ,“Design Warrior’s Guide to FPGA”, 2004, Elsevier

Reference links:

1. https://www.sanfoundry.com/vlsi-questions-answers-aptitude-test/
2. Free Tool : https://www.edaplayground.com/
3. https://github.com/

**Suggested FPGA Hardware Boards:

1. Numato FPGA boards - https://numato.com/shop/
2. Papilio FPGA boards - http://store.gadgetfactory.net/fpga/
3. CMOD s6 - https://store.digilentinc.com/cmod-s6-breadboardable-spartan-6-fpga-module/
4. TinyFPGA - https://tinyfpga.com/
5. Zync,Zed Board - https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html
6. Artix -7, Kinetex Boards - https://store.digilentinc.com/arty-a7-artix-7-fpga-development-board/

Suggested Software tools:

1. Xilinx ISE Webpack
2. Modelsim/Questasim
3. Leonardo spectrum
4. MATLAB
5. Quartus
6. Actel
7. Icarus Verilog Simulator

Suggested Projects (FPGA downloading is must)

1) Shift-Add Multiplication,
2) Hardware Multipliers
3) Programmed Multiplication
4) Shift-Subtract Division
5) CORDIC Algorithm
6) Design of functions such as reciprocal, square root, sine, cosine, exponential
7) Wallace Multiplier
8) 8- Bit ALU
9) Matrix Multiplication
10) Booths Multiplier
11) NRZ,NRZI etc coding techniques

Suggested Courses

1. NPTEL Verilog Programming - Free
2. Workshops -Xilinx University Program- Freely available

Suggested Competitions for Funding

1. Government Swadeshi Microprocessor Challenge
2. IICDC – TI challenge
3. Sankalp Semiconductors Hackathons

University of Mumbai

No. AAMS(UG)/ 80 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/55 of 2018-19, dated 6th July, 2018 relating to the revised syllabus as per the (CBCS) for the T.E. in Mechanical Engineering (Printing & Packaging Technology (Sem – V & VI).

They are hereby informed that the recommendations made by the Board of Studies in Mechanical Engineering at its meeting held on 15th May, 2021 and subsequently passed by the Board of Deans at its meeting held on 11th June, 2021 vide item No. 6.8 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No.6.8 (R) and that in accordance therewith, the revised syllabus (Rev – 2019 'C' Scheme) for the B.E. in Mechanical Engineering (T.E. – Sem. V and VI.) has been brought into force with effect from the academic year 2021-22 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
30th September, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.8(R) 29/06/2021

****

No. AAMS(UG)/ 80-A of 2021-22 MUMBAI-400 032 30th September, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Mechanical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC- 29/06/2021
Item No.- 6.8

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Mechanical Engineering

Third Year with Effect from AY 2021-22

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year B.E. in Mechanical Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~ / **Revised** (Strike out which is not applicable)
9	To be implemented from Academic Year	**2021-2022**

Date

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C’ Scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A’ and ‘B’ respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the Institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

When the entire world is discussing about ‘Industry 4.0’, we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders.We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering
Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa S.Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member

Program Structure for Third Year Engineering
Semester V &VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC501	Mechanical Measurements and Controls	3	--	3	--	3
MEC502	Thermal Engineering	3	--	3		3
MEC503	Dynamics of Machinery	3	--	3	--	3
MEC504	Finite Element Analysis	3	--	3	--	3
MEDLO501X	Department Level Optional Course – 1	3	--	3	--	3
MEL501	Thermal Engineering	--	2	--	1	1
MEL502	Dynamics of Machinery	--	2	--	1	1
MEL503	Finite Element Analysis	--	2	--	1	1
MESBL501	Professional communication and ethics –II	--	2*+2	--	2	2
MEPBL501	Mini Project – 2 A	--	4$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC501	Mechanical Measurements and Controls	20	20	20	80	3	--	--	100
MEC502	Thermal Engineering	20	20	20	80	3	--	--	100
MEC503	Dynamics of Machinery	20	20	20	80	3	--	--	100
MEC504	Finite Element Analysis	20	20	20	80	3	--	--	100
MEDLO501X	Department Level Optional Course – 1	20	20	20	80	3	--	--	100
MEL501	Thermal Engineering	--	--	--	--	--	25	--	25
MEL502	Dynamics of Machinery	--	--	--	--	--	25	25	50
MEL503	Finite Element Analysis	--	--	--	--	--	25	25	50
MESBL501	Professional communication and ethics - II	--	--	--	--	--	25	25	50
MEPBL501	Mini Project – 2 A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**125**	**100**	**725**

* Theory class to be conducted for full class, $ indicates work load of Learner (Not Faculty), for Mini Project;

SBL – Skill Based Laboratory
PBL – Project Based Learning

Department Level Optional Course – 1

Course Code	**Department Level Optional Course – 1**
MEDLO5011	Optimization Techniques
MEDLO5012	Design of Experiments
MEDLO5013	Computational Methods

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract/Tut.	Theory	Pract.	Total
MEC601	Machine Design	4	--	4	--	4
MEC602	Turbo Machinery	3	--	3		3
MEC603	Heating, Ventilation, Air conditioning and Refrigeration	3	--	3	--	3
MEC604	Automation and Artificial Intelligence	3	--	3	--	3
MEDLO602X	Department Level Optional Course – 2	3	--	3	--	3
MEL601	Machine Design	--	2	--	1	1
MEL602	Turbo Machinery	--	2	--	1	1
MEL603	Heating, Ventilation, Air conditioning and Refrigeration	--	2	--	1	1
MESBL601	Measurements and Automation	--	4	--	2	2
MEPBL601	Mini Project – 2 B	--	$4^{\$}$	--	2	2
Total		**16**	**14**	**16**	**07**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC601	Machine Design	20	20	20	80	3	--	--	100
MEC602	Turbo Machinery	20	20	20	80	3	--	--	100
MEC603	Heating, Ventilation, Air conditioning and Refrigeration	20	20	20	80	3	--	--	100
MEC604	Automation and Artificial Intelligence	20	20	20	80	3	--	--	100
MEDLO602 X	Department Level Optional Course – 2	20	20	20	80	3	--	--	100
MEL601	Machine Design	--	--	--	--	--	25	25	50
MEL602	Turbo Machinery	--	--	--	--	--	25	--	25
MEL603	Heating, Ventilation, Air conditioning and Refrigeration	--	--	--	--	--	25	25	50
MESBL601	Measurements and Automation	--	--	--	--	--	25	25	50
MEPBL601	Mini Project – 2 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**125**	**100**	**725**

$ indicates work load of Learner (Not Faculty), for Mini Project;

SBL – Skill Based Laboratory;
PBL – Project Based Learning

Department Level Optional Course – 2

Course Code	**Department Level Optional Course – 2**
MEDLO6021	Press Tool Design
MEDLO6022	Tool Engineering
MEDLO6023	Metal Forming Technology

Course Code	Course Name	Credits
MEC501	**Mechanical Measurements and Controls**	**03**

Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.
5. To study concept of mathematical modelling of the control system.
6. To acquaint with control system under different time domain.

Outcomes: Learner will be able to…

1. Handle, operate and apply the precision measuring instruments / equipment's.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Classify and select proper measuring instrument for displacement, pressure, flow and temperature measurements.
5. Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability.

Module	Details	Hrs.
1	**1.1** Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization. **1.2** Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	**06**
2	**2.1** Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer. **2.2** Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. **2.3** Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer. **2.4** Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.	**08**
3	**3.1** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. **3.2** Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.	**06**
4	**4.1** Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper	**08**

	Transducer **4.2** Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors **4.3** Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges **4.4** Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter **4.5** Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers	
5	**5.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **5.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra **5.3** Transient and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	**06**
6	**6.1** Stability analysis: Introduction to concepts of stability, The Routh criteria for stability **6.2** Experimental determination of frequency response, Stability analysis using Root locus, Bode plot	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering. Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal
6. Control System Engineering by Nagrath I.J. and Gopal M, Wiley EasternLtd.
7. Modem Control engineering: by K. Ogata, Prentice Hall
8. Control systems by Dhanesh Manik, Cengage Learning
9. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, OxfordUniversity Press.
10. Instrumentation and Control System, W. Bolton, Elsevier
11. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
12. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
13. Mechanical Measurements by S P Venkateshan, John Wiley & Sons

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/103/112103261/ - Principles of Mechanical Measurement, IIT Guwahati
https://nptel.ac.in/courses/112/107/112107242/ - Mechanical Measurement System, IIT Roorkee
https://nptel.ac.in/courses/112/106/112106138/ - Mechanical Measurements and Metrology, IIT Madras

Course Code	Course Name	Credits
MEC502	**Thermal Engineering**	**03**

Objectives

1. To study the heat transfer concepts applicable for steady state and transient conditions.
2. To study mathematical modeling and design concepts of heat exchangers.
3. To familiarize with the working of S.I. and C.I. engines and their performance.

Outcomes: Learner will be able to…

1. Analyze the three modes of heat transfer in engineering application.
2. Develop mathematical models for different modes of heat transfer.
3. Analyze performance parameters of different types of heat exchangers.
4. Identify and analyze the Transient heat Transfer in engineering applications.
5. Explain construction and working of different components of internal combustion engines.
6. Evaluate engine performance and emission characteristics.

Module	Details	Hrs
1	1.1. **Modes of Heat Transfer**: Mechanism of conduction, Convection and radiation heat transfer and it's Governing laws. 1.2. Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equations for cylindrical and spherical coordinates, no derivation). 1.3. Steady state heat conduction through plane wall, composite wall, cylinder, composite cylinder, sphere and composite sphere. Thermal contact resistance. Critical radius of insulation in cylinder and sphere.	**07**
2	2.1 **Heat transfer from Extended Surfaces**: Types of extended surfaces and its significance. Governing differential equation for fin (Finite, Infinite, and Insulated tips) and its solution. Fin efficiency and effectiveness. Analysis of Thermometric well. 2.2 **Unsteady state heat transfer:** Lumped heat capacity Analysis. Applications of unsteady state heat transfer, Thermal time constant.	**06**
3	3.1 **Convection:** Free and Forced convection. **External Flow**: Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate. **Internal Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes. General thermal analysis: Constant heat flux and constant surface temperature. 3.2 **Boiling and Condensation**: Introduction to Different boiling regimes, Film condensation, Drop wise Condensation. 3.3 **Radiation:** Basics laws of radiation and heat exchange between two bodies.	**07**

4	4.1 **Mass Transfer**: Introduction to Mass Transfer, governing equations of mass transfer. Mass transfer coefficient. 4.2 **Heat Exchangers:** Types of heat exchangers, Overall heat transfer coefficient, LMTD, Effectiveness, Effectiveness – Number of Transfer Unit (ε- NTU) method, Correction factor for multi pass (up to 2 passes on shell and tube side) and cross flow heat exchanger.	**07**
5	5.1 Introduction to I.C. Engines and its Classification. Working of Four stroke and Two-stroke engines, Valve Timing Diagram. Fuel air cycles, Actual cycle. 5.2 Introduction to Fuel Supply, Ignition, combustion and knocking in SI Engines. MPFI in SI Engine. 5.3 Introduction to Fuel Injection system, Combustion and detonation in CI Engines.	**06**
6	6.1 **Engine Testing and Performance**: Measurement of various performance parameters, Performance characteristic of SI and CI Engine, Effect of load and speed on performance parameters, Heat balance sheet. 6.2 **Engine Emission and Control:** Sources of Engine Emissions**,** Constituents of S.I. and C.I. Engine exhaust and their effects on environment and health. Study of emission (Euro & Bharat stage) norms, Control methods for S.I and C I engine emissions.	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First' test based on approximately 40% of content and second test based on remaining content (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

Text/Reference Books:

1. Fundamentals of Heat and Mass Transfer by F.P. Incropera and D P deWitt, Wiley India 3rd Edition.
2. Introduction to thermodynamics and Heat transfer by YunusACengel 2ndEdition, McGraw Hill.
3. Fundamentals of Heat and Mass Transfer, M. Thirumaleshwar, Pearson Education India, 2009.
4. Introduction to Heat Transfer, Som S. K ,PHI Publication.
5. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press.
6. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON.
7. Heat Transfer by J P Holman, Mcgraw Hill.
8. Heat Transfer by S P Sukhatme, University Press.
9. Heat and Mass Transfer by PK Nag, TMH.
10. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
11. Internal Combustion Engines, Shyam Agrawal, New Age International
12. Internal Combustion Engine, Mathur and Sharma
13. Internal Combustion Engines, Mohanty, Standard Book House
14. Internal Combustion Engine, Gills and Smith
15. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
16. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
17. Internal Combustion Engine, V Ganesan, TMH
18. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
19. Internal Combustion Engine, S.L. Beohar
20. Internal Combustion Engine, P.M Heldt.
21. Internal Combustion Engine, E.F. Oberi.
22. Internal Combustion Engine by Domkundwar

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/101/112101097/ - Heat and Mass Transfer, IIT Bombay
https://nptel.ac.in/courses/112/105/112105248/ - Heat Exchangers: Fundamentals and Design Analysis, IIT Kharagpur
https://nptel.ac.in/courses/112/104/112104033/ - Engine Combustion, IIT Kanpur
https://nptel.ac.in/courses/112/103/112103262/ - IC Engines and Gas Turbines, IIT Guwahati

Course Code	Course Name	Credits
MEC503	**Dynamics of Machinery**	**03**

Objectives:

1. To acquaint with working principles and applications of Governors / Gyroscope
2. To study static and dynamic force analysis in the mechanisms
3. To familiarize with basics of mechanical vibrations
4. To study the balancing of mechanical systems

Outcomes: Learner willbe able to…

1. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems
2. Illustrate basic of static and dynamic forces
3. Determine natural frequency of element/system
4. Determine vibration response of mechanical elements / systems
5. Design vibration isolation system for a specific application
6. Demonstrate basic concepts of balancing of forces and couples

Module	Details	Hrs.
1.	**Governors and Gyroscopes:** **1.1 Governors:** Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors includingPerformance characteristics, Governors effortand power. **1.2 Gyroscope:** Introduction, Gyroscopic couple and its effect on spinning bodies, naval shipsduring steering, pitching, rolling and their stabilization.	**07**
2.	**2.1** Static and Dynamic force analysis of Slider crank mechanism (neglecting mass of connecting rod and crank), , Turning moment on crank shaft **2.2** Dynamically equivalent systems to convert rigid body into two mass with and without correction couple(Case study- Connecting rod)	**05**
3.	**3.1Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Importance of study of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis **3.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	**06**
4.	**4.1 Free Damped Single Degree of Freedom Vibration System:**Introduction to different methods of damping, Study and analysis of **1)** Viscous damped system (under damped, critically damped, over damped; Logarithmic decrement) **2)**Coulomb's damping (Combined Viscous and Coulomb damping excluded) **4.2 Equivalent Single Degree of Freedom Vibration System:** Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system,	**06**
5.	**5.1 Forced Single Degree of Freedom Vibratory System:**Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper)	**08**

	5.2 Vibration Isolation and Transmissibility: Force Transmissibility, motion transmissibility, typical isolators & mounts. **5.3 Vibration Measuring instruments:**Principle of seismic instruments, vibrometer, accelerometer - undamped and damped, Introduction to conditioning monitoring and fault diagnosis	
6.	**6.1 Rotor Dynamics:**Critical speed of single rotor, undamped and damped **6.2 Balancing:**Static and Dynamic balancing of multi rotor system(up to four rotors), balancing of reciprocating masses in In-line engines(up to four cylinders) , Introduction to V-engines (excluding other radial engines)	**07**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests.
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

Text/Reference Books:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
7. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
8. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
9. Mechanical Vibraitons by G.K.Grover
10. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
11. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
12. Vibration Analysis by P. Srineevasan, TMH
13. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
14. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
15. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/101/112101096/ - Dynamics of Machines, IIT Bombay
https://nptel.ac.in/courses/112/107/112107212/ - Introduction to Mechanical Vibration, IIT Roorkee

Course Code	Course Name	Credits
MEC504	**Finite Element Analysis**	**03**

Prerequisite:

Knowledge of:

- Differential equations (Formulation and solution, Types-Ordinary, Partial, Order and degree of the DE and the boundary conditions)
- Matrix algebra (Matrix operations, gauss elimination method to get inverse the inverse of matrix)
- Basics of the core field (Governing laws, relationship between the various variables and constants –like in structural field stress-strain,Thermal field-temp, heat transfer rate etc

Objectives:

1. To understand the concepts of FEA and its applicability to different engineering field problems.
2. To understand the representation of the physical model into an equivalent FEA model and steps to solve it.
3. To acquaint with application of numerical techniques for solving problems.

Outcomes: Learner will be able to…

1. Solve differential equations using weighted residual methods.
2. Develop the finite element equations to model engineering problems governed by second order differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system.
6. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Details	Hrs
1	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions-types-essential/natural etc. 1.3Approximate solution of differential equations, Weighted residual techniques (Galerkin , Subdomain method).	**05**
2	**FEA Procedure:(Pre-processing, Processing, Post-processing)** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', assembly concepts to develop system equation.	**08**

3	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors. 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams	**10**
4	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element. 4.3 Convergence criterion, sources of errors	**05**
5	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axi-symmetric problems 5.2 Jacobian matrix, stress analysis of CST.	**06**
6	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices. 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams.	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by J N Reddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John- Wiley Sons
7. The Finite Element Method in Engineering by S. S. Rao, Butter Worth Heinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/104/112104193/
https://nptel.ac.in/courses/105/106/105106051/
https://nptel.ac.in/courses/112/104/112104115/
https://nptel.ac.in/courses/112/103/112103295/
https://nptel.ac.in/courses/112/106/112106135/
https://nptel.ac.in/courses/112/106/112106130/
https://nptel.ac.in/courses/105/105/105105041/
https://nptel.ac.in/courses/112/104/112104116/

Course Code	Course Name	Credits
MEDLO5011	**Optimization Techniques**	**03**

Objectives:

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent tools in optimization

Outcomes: Learner will be able to…

1. Identify the types of optimization problems and apply the calculus method to single variable problems.
2. Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
6. Apply Design of Experiments method for Optimization

Module	Details	Hours
1	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems. Classical Optimization Techniques: Single variable optimization	**06**
2	Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP Transportation and Assignment Models.	**08**
3	Integer Programming Model: Gomory's cutting plane method, Branch & Bound Technique. Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton's method. Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.	**08**

4	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming. Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness **(Only concepts)**	**08**
5	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method TOPSIS Method PROMETHEE	**06**
6	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design Application of related software (Minitab, Design Expert or MATLAB)	**08**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. Pablo Pedregal, "Introduction to Optimization", Springer
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. R V Rao, “Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making” (Springer Publication).

7. Ritter, H., Martinetz, T., &Schulten, K., Addison,“Neural Computation and Self-Organizing Maps”-Wesley Publishing Company
8. Douglas C.Montgomery,“Design and analysis of experiments”(John Wiley & Sons Inc.)
9. Saravanan R,“Manufacturing Optimization through Intelligent Techniques”, Taylor & Francis (CRC Press)-2006.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/101/112101298/ - Optimization from Fundamentals, IIT Bombay

Course Code	Course Name	Credits
MEDLO5012	**Design of Experiments**	**03**

Objectives: -

1. To obtain clear understanding of use of statistics in experimentation
2. To obtain clear understanding of scheme of experimentation and its effect on accuracy of experimentation
3. To obtain knowledge of how to analyze results from such investigations to obtain conclusions
4. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan, design, and conduct experimental investigations efficiently and effectively;
2. Understand strategy in planning and conducting experiments;
3. Choose an appropriate experimentation scheme to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.

Module	Details	Hrs
1	**Introduction, Background and Overview:** A brief history of DOE-When to use DOE- Basic principles of DOE & Some typical applications. Overview of basic statistical concepts, Simple Comparative Experiments, Single Factor experiments, Randomized Blocks, Latin Square Designs and extensions. Testing of Hypothesis (‘T’&‘F’ test), Introduction to Factorial Designs, 2^k Designs.	**06**
2	**Full Factorial Design:** The basics of "full factorials”, ANOVA,Factorial effects including interaction effects and plots	**06**
3	**Two & Three Level Fractional Factorial Design:** Objective, The one-half fraction and one-quarter of the 2^k design, 2^{k-p} fractional factorial design, 3-level & Mixed-level Factorials & Fractional Factorials.	**08**
4	**The Robust Design:**Basics of robust designs, Loss Function, Taguchi designs, Orthogonal Arrays, Linear Graphs and Interaction effects, Signal to Noise Ratio, Parameter Design, Tolerance Design,Robust design example.	**08**
5	**Response Surface Methodology:** First & second order experiments, Analysis of second-order response surfaces, Central composite designs, Plackett-Burman designs, process optimization & reliability improving experiments	**06**
6	Experiment Design According to Shainin, Multi-variate charts, components search, paired comparisons	**06**

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. Statistics for Experimenters,Box, GEP, Hunter, WG, and Hunter, JS, 1978, Wiley.
2. Empirical Model-Building and Response Surfaces,Box, GEP and Draper, NR 1987, Wiley.
3. Experimental Designs, Cochran, WG and Cox, GM, 1957, Wiley.
4. The Design of Experiments, 8th Ed., Fisher, RA, 1966, Hafner.
5. Design and Analysis of Experiments (Vol I), Hinkelmann, K and Kempthorne, O, 1994, Wiley.
6. Optimal Design of Experiments,Pukelsheim, F, 1993, Wiley.
7. Statistical Principles in Experimental Design,2nd Ed., Winer, BJ, 1962, McGraw-Hill.
8. Engineering Methods for Robust Product Design: Using Taguchi Methods in Technology and Product Development, Fowlkes WY, Creveling CM, 1995, Addison-Wesley Publishing Company
9. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001
10. Total Quality Management, 4th Ed,Besterfield D.H., Carol BesterfieldM ,MaryBesterfileld Sacre, Besterfield G.H.,Urdhwareshe H, Urdhwareshe R,2015, Pearson

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/110/105/110105087/ - Design and Analysis of Experiments, IIT Kharagpur

https://nptel.ac.in/courses/111/104/111104075/ - Analysis of Variance and Design of Experiments-I, IIT Kanpur

https://nptel.ac.in/courses/111/104/111104078/ - Analysis of Variance and Design of Experiments-II, IIT Kanpur

Course Code	Course Name	Credits
MEDLO5013	**Computational Methods**	**03**

Objectives:

1. Introduction to analytical and numerical techniques.
2. Application of mathematical modelling to mechanical systems.
3. Learn the significance of statistical techniques and data interpolation.

Outcomes: Learner will be able to…

1. Understand and develop mathematical models of physical systems.
2. Identify an appropriate mathematical formulation to linear algebraic equations.
3. Build an appropriate mathematical formulation to non-linear algebraic equations.
4. Evaluate and interpret the data regression, curve fitting and statistics.
5. Apply the numerical techniques and numerical schemes.
6. Formulate the concept of numerical methods in realistic applications.

Module	Details	Hrs
1	**Introduction to Computational Methods** Motivation and applications of Computational Methods. Computation and Error Analysis:Accuracy and precision; Truncation andround-off errors (Numericals); Binary Number System; Error propagation.	**06**
2	**Linear Systems and Equations** Matrix representation: Cramer's rule; Gauss Elimination. Matrix Inversion: LUDecomposition; Iterative Methods;Relaxation Methods; Eigen Values and Eigen Vectors.	**06**
3	**Non Linear Algebraic Equations:** Bracketing methods: Bisection, Regula-Falsi. Crouts Method: LU Decomposition. Open methods: Secant, Fixed pointiteration, Newton-Raphson; MultivariateNewton’s method.	**06**
4	**Regression and Curve Fitting** Interpolation function; Cubic Splines; Multi regression analysis, polynomial regression. **Statistical methods:** Statistical representation of data, modeling and analysis of data, test of hypotheses. **Fuzzy Logic:** Introduction to fuzzy logic, Fuzzy Logic Systems Architecture, Case study of Mechanical system.	**08**
5	**Integration and Integral Equations** Newton Cotes Quadrature **ODEs: Initial Value Problems** Euler's methods; Predictor-corrector method (Adam’s Moulton, Milne’s Method) **ODEs: Boundary Value Problems** Finite difference Method; Finite Element Method, Finite Volume Method	**07**

6	**Application of Numerical Methods** Predict vibration response of components to intricate profile generated by different machine tools, Design next generation Formula One cars to working at the cutting edge of robotics, Predict behaviour of flows to estimation of heat transfer in complex scenarios; Crank Nicolson method – Solution of 1-D Wave equation.	06

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then
4. part (b) will be from any module other than module 3)
5. Only **Four questions need to be solved**.

Text/Reference Books:

1. S. P. Venkateshan& Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books Pvt. Ltd., 1st Edition, (2014) ISBN: 978-0-12-416702-5.
2. Steven C. Chapra& Raymond P.Canale, "Numerical Methods for Engineers", Mc-Graw Hill Education, 8TH Edition, (2020), ISBN: 1260571386
3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001) ISBN: 0-8247-0443-6.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, 2019.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fifth Edition, 2012.
6. Rajesh Kumar Gupta, Numerical Methods – Fundamentals and Applications, Cambridge University Press, First Edition, 2019.
7. Gupta and Santosh K., "Numerical Methods for Engineers", 4th Edition, New Age International Publishers, 2019, ISBN: 9789387788794
8. FerzigerJ.and M. Peric, "Computational Methods for Fluid Dynamics" 3rd Edition, Springer, (2001) ISBN: 9783540420743.
9. Versteeg H., and W. Malalasekra,"An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, PHI(2007) ISBN: 9780131274983.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/127/106/127106019/ - Numerical Methods for Engineers, IIT Madras
https://nptel.ac.in/courses/111/107/111107105/ - Numerical Methods, IIT Roorkee
https://nptel.ac.in/courses/111/106/111106101/ - Numerical Analysis, IIT Madras
https://nptel.ac.in/courses/111/107/111107107/ - Numerical Methods: Finite Difference Approach, IIT Roorkee

Course Code	Course Name	Credits
MEL501	**Thermal Engineering**	**01**

Objectives:

1. To familiarize the concept of various modes of heat transfer through experimental approaches.
2. To make conversant of concept of heat transfer mechanisms in various engineering applications.
3. To acquaint with the various methods for measurement of engine performance and emission parameters.

Outcomes: Learner will be able to…

1. Estimate thermal conductivity of engineering materials.
2. Evaluate performance parameters of extended surfaces.
3. Analyze heat transfer parameters in various engineering applications.
4. Analyze engine performance and emission parameters at different operating conditions.

List of Experiments

Group A (any five)

1. Measurement of thermal conductivity of metal rod/ liquids/insulating powder.
2. Measurement of thermal conductivity of composite wall.
3. Performance analysis of extended surfaces under free and force convection.
4. Measurement of heat transfer coefficient for flow over flat surface in free/forced convection.
5. Measurement of heat transfer coefficient for flow through tubes in free/forced convection.
6. Verification of Stefan Boltzmann Law.
7. Measurement of emissivity of Grey surface.
8. Determination of time constant of different materials under unsteady state heat transfer.
9. Estimation of overall heat transfer coefficient and effectiveness of heat exchanger.

Group B (Any four)

1. Study of performance and emissions characteristics of a Single Cylinder, Four-Stroke, Petrol Start, Kerosene Engine at constant speed (Load Test).
2. Study of performance and emissions characteristics of a Single Cylinder, Four- stroke Diesel Engine at constant speed (With Electrical/ Rope Brake Dynamometer) (Load Test) along with Heat Balance Sheet.
3. Study of performance and emissions characteristics of a Single Cylinder/Multi Cylinder, Two/Fourstroke petrol Engine at constant Speed/Load.
4. Study of performance and emissions characteristics of a Single Cylinder/ Multi Cylinder, Two/Four stroke petrol Engine at constant Speed along with heat balance sheet.
5. Determination of frictional power and mechanical efficiency of the Multi-cylinder Petrol Engine by Morse test.
6. Study of performance and emissions characteristics of a Single Cylinder, Four- stroke Diesel Engine at constant speed along with Heat Balance Sheet (With Electrical/ Rope Brake Dynamometer) (Load Test) using alternative fuels.
7. Study of performance and emissions characteristics of a Single Cylinder/Multi Cylinder, Four-stroke Petrol Engine at constant speed/load along with Heat Balance Sheet (With Electrical/ Rope Brake Dynamometer) (Load Test) under dual fuel mode.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned in group A and group B.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

Virtual Lab

https://mfts-iitg.vlabs.ac.in/ - Fluid and Thermal Sciences Lab, IIT Guwahati
https://vlab.amrita.edu/index.php?sub=1&brch=194 - Heat & Thermodynamics Virtual Lab, Amrita Vishwa Vidyapeetham
http://vlabs.iitkgp.ernet.in/rtvlas/# - Virtual Lab on Automotive Systems

Course Code	Course Name	Credits
MEL502	**Dynamics of Machinery**	**01**

Objectives:

1. To acquaint with working principles and applications of gyroscope and governors
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to…

1. Plot and analyze governor characteristics
2. Analyze gyroscopic effect on laboratory model
3. Estimate natural frequency of mechanical systems
4. Analyze vibration response of mechanical systems
5. Determine damping coefficient of a system
6. Balance rotating mass

Term Work: (Comprises part a and b)

a) **List of Experiments: (Minimum Eight)**
b) **Assignment:**

Sr. No.	Title of Experiment	Laboratory Sessions
1	Experiments on Governors- Porter Governor, Hartnell Governor	2 hrs
2	Experiments on Gyroscope	2 hrs
3	Determine natural frequency of compound pendulum, equivalent simple pendulum system.	2 Hrs.
4	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel	2 Hrs
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	2 Hrs
6	Experiment on whirling of shaft	2 Hrs
7	Determination of damping coefficient of any system/media	2 Hrs
8	Experimental balancing of single and multi-rotor system	2 Hrs
9	Measurement of vibration response of a system	2 Hrs
10	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2 Hrs

Minimum two problems on each of the following topics:

1. Governors and Gyroscope
2. Static and dynamic force analysis
3. Vibration, isolation and control
4. Vibration measuring instruments
5. Rotor dynamics

Project Based Learning may be incorporated by judiciously reducing number of assignments

Term Work The distribution of marks for term work shall be as follows:

- Laboratory work : 15 marks.
- Assignments : 05 marks.
- Attendance : 05 Marks.

Virtual Labs

https://dom-nitk.vlabs.ac.in/List%20of%20experiments.html – Dynamics of Machine Lab, NITK, Surathkal

http://mdmv-nitk.vlabs.ac.in/# - Machine Dynamics and Mechanical Vibrations Lab, NITK, Surathkal

https://mv-iitg.vlabs.ac.in/ - Virtual Labs for Mechanical Vibrations, IIT Guwahati

Course Code	Course Name	Credits
MEL503	**Finite Element Analysis**	**01**

Objectives:

1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to…

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

a. List of Experiments: Students should use the commercial software or open source application programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs (Minimum 6) should be included in the Journal.

The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction
7. Any one problem for analysis of Beams.

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.(using approach of refining mesh and or order of the element)

b. Course Project: (Any one task out of the following proposed list **)**

A group of not more than four students, shall do

1) Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.
2) Develop the program to verify the results obtained by manual calculations for simple 1D/2D problems using Python, MATLAB programming platform etc.
3) Simulate a problem and validate the results with experimental results (the test rigs from Strength of material /Heat transfer/Dynamics of machine/fluid lab etc may be used for obtaining the experimental results)

The distribution of marks for term work shall be as follows:

Part a:10 marks.
Part b:10 marks.
Attendance: 05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:

a. Practical performance ……**15** marks

b. Oral……………….. **10** marks

Evaluation of practical examination to be done based on the experiment performed andthe output of the experiments during practical examination.

Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books:

1. Programming the Finite Element Method, I M Smith,D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik,Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by PaletiSrinivas,Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.
6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

Course Code	Course Name	Credits
MESBL501	**Professional Communication And Ethics - II**	**02**

Objectives:

Learners should be able to:

1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitudes and skills.
6. Understand the importance of integrity and develop a personal code of ethics.

Outcomes: Learners will be able to…

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

MODULE	DETAILS	HOURS
MODULE 1 - ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)		
1.1. Purpose and Classification of Reports	**Classification on the basis of:** ● Subject Matter (Technology, Accounting, Finance, Marketing, etc.) ● Time Interval (Periodic, One-time, Special) ● Function (Informational, Analytical, etc.) ● Physical Factors (Memorandum, Letter, Short & Long)	**06**
1.2. Parts of a Long Formal Report	● Prefatory Parts (Front Matter) ● Report Proper (Main Body) ● Appended Parts (Back Matter)	
1.3. Language and Style of Reports	● Tense, Person & Voice of Reports ● Numbering Style of Chapters, Sections, Figures, Tables and Equations	

	● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
1.4. Definition, Purpose & Types of Proposals	● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
1.5. Parts of a Proposal	● Elements ● Scope and Limitations ● Conclusion	
1.6. Technical Paper Writing	● Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) ● Language and Formatting ● Referencing in IEEE Format	
MODULE 2 - EMPLOYMENT SKILLS		
2.1. Cover Letter & Resume	● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional & Combination)	**06**
2.2 Statement of Purpose	● Importance of SOP ● Tips for Writing an Effective SOP	
2.3 Verbal Aptitude Test	● Modelled on CAT, GRE, GMAT exams	
2.4. Group Discussions	● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	
2.5. Personal Interviews	● Planning and Preparation ● Types of Questions ● Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) ● Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
MODULE 3 - BUSINESS MEETINGS		
3.1. Conducting Business Meetings	● Types of Meetings ● Roles and Responsibilities of Chairperson, Secretary and Members ● Meeting Etiquette	**02**

3.2. Documentation	● Notice ● Agenda ● Minutes	
MODULE 4 -TECHNICAL/ BUSINESS PRESENTATIONS		
4.1. Effective Presentation Strategies	● Defining Purpose ● Analysing Audience, Location and Event ● Gathering, Selecting &Arranging Material ● Structuring a Presentation ● Making Effective Slides ● Types of Presentations Aids ● Closing a Presentation ● Platform Skills	**02**
4.2 Group Presentations	● Sharing Responsibility in a Team ● Building the contents and visuals together ● Transition Phases	
MODULE 5 - INTERPERSONAL SKILLS		
5.1. Interpersonal Skills	● Emotional Intelligence ● Leadership & Motivation ● Conflict Management & Negotiation ● Time Management ● Assertiveness ● Decision Making	**08**
5.2 Start-up Skills	● Financial Literacy ● Risk Assessment ● Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
MODULE 6 - CORPORATE ETHICS		
6.1. Intellectual Property Rights	● Copyrights ● Trademarks ● Patents ● Industrial Designs ● Geographical Indications ● Integrated Circuits ● Trade Secrets (Undisclosed Information)	**02**
6.2. Case Studies	● Cases related to Business/ Corporate Ethics	

List of Assignments for Termwork
(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal

3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
7. IPR
8. Interpersonal Skills
9. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Guidelines for Internal Assessment

Term Work	25 Marks
Assignments	10 Marks
Attendance	05 Marks
Presentation slides	05 Marks
Book Report (hard copy)	05 Marks
Internal Oral -	25 Marks

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	10 Marks
Project presentation (Individual Presentation)	10 Marks
Group Dynamics	05 Marks

Suggested Reading

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational Behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Virtual Labs

https://ve-iitg.vlabs.ac.in/- Virtual English and Communication Virtual Lab, IIT Guwahati

http://vlabs.iitb.ac.in/vlabs-dev/labs/communication/- Professional Communication Virtual Lab, IIT Bombay

Course code	Course Name	Credits
MEPBL501	**Mini Project - 2A**	**02**

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

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Assessment criteria of Mini Project

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Credits
MEC601	**Machine Design**	**04**

Objectives:

1. To study basic principles of machine design
2. To familiarize with use of design data books & various codes of practice
3. To acquaint with functional and strength design principles of important machine elements
4. To familiarize selection of standard elements such as rolling element bearings, belts etc.
5. To make conversant with preparation of working drawings based on designs

Outcomes: Upon successful completion of this course, the learner will be able to

1. Use design data book/standard codes to standardise the designed dimensions
2. Design Knuckle Joint, cotter joint and Screw Jack
3. Design shaft under various conditions and couplings
4. Select bearings for a given applications from the manufacturers catalogue.
5. Select and/or design belts and flywheel for given applications
6. Design springs, clutches and brakes

Module	**Details**	**Hrs**
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers Thick Cylinders: Design of thick cylinders subjected to an internal pressure using Lame's equation	**08**
2	Design against static loads: Socket and Spigot Cotter joint, Knuckle joint, Bolted and welded joints under eccentric loading; Power Screw- Screw Jack.	**08**
3	3.1 Design against fluctuating loads: variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit-estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, 3.2 Design of Shaft: power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria. Keys: Types of Keys and their selection based on shafting condition. Couplings: Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	**12**
4	4.1 Rolling Contact Bearings: Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing) 4.2 Sliding Contact Bearings: Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydro static bearings,	**08**
5	5.1 Design and selection of Belts: Flat and V-belts with pulley construction. 5.2 Design and selection of standard roller chains. 5.3 Design of Flywheel – Introduction, Fluctuation of energy and speed, turning moment	**08**

	diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms, Construction of flywheel.	
6	6.1 Design of Springs: Helical compression, Tension Springs under Static and Variable loads, Leaf springs. 6.2 Design of Clutches: Introduction, types, Basic theory of plate and cone type clutches, Design of single plate, multi-plate andwith spring, lever design andthermal, wear considerations. 6.2 Design of Brakes: Design of single shoe brake.	**08**

Assessment:
Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecturehours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 thenpart (b) will be from any module other than module 3)
4. Only Four questions need to be solved

Text/Reference Books:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Machine Design by Reshetov, Mir Publication
7. Machine Design by Black Adams, McGraw Hill
8. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
9. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas& Co
10. Design of Machine Elements by V.M.Faires
11. Design of Machine Elements by Spotts
12. Recommended Data Books – Design Data: Data Book of Engineers by PSG College, KalaikathirAchchagam

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105124/ - Design of Machine Elements, IIT Kharagpur
https://nptel.ac.in/courses/112/106/112106137/ - Machine Design-II, IIT Madras

Course Code	Course Name	Credits
MEC602	**Turbo Machinery**	**03**

Objectives

1. To apply principles of thermodynamics and fluid mechanics to turbomachines.
2. To learn the design and significance of various components of the turbomachine.
3. To estimate various parameters related to turbo machines using the governing equations.
4. To evaluate the performance of turbo machines.

Outcomes: Learner will be able to…

1. Define various parameters associated with steam generators and turbo machines.
2. Identify various components and mountings of steam generators with their significance.
3. Identify various turbo machines and explain their significance.
4. Apply principles of thermodynamics and fluid mechanics to estimate various parameters like mass flow rate power, torque, efficiency, temperature, etc.
5. Evaluate performance of SG and Turbo machines and apply various techniques to enhance performance.
6. Evaluate various phenomena related to performance like cavitation, choking, surging.

Module	Details	Hrs
1	**1.1 Steam Generators-** Layout of Thermal Power Plant, Classification of boiler, Difference between Fire tube and Water tube boiler with examples, Low pressure and high pressure boilers, once through boiler, important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency. **1.2 Introduction to turbo machines:** 1.2.1 Review of Thermodynamic principles, compressible gas flow relations, estimation of non-dimensional performance parameters for incompressible flow, specific speed. 1.2.2 Basic Euler's theory of turbo machines and it application to pumps, turbines and compressors.	**04** **04**
2	**HydraulicTurbines:** Basic theory, classification of turbines, theory of impulse and reaction turbines, estimation of work done, efficiency, characteristics of turbines, concept of draft tube and its types	**06**
3	**Pumps** **3.1** Classification of pumps, definition of pumping systems and system characteristics. **3.2 Centrifugal pumps:** Construction, estimation of work done, efficiency, characteristics, determination of operating point, cavitation and NPSH, specific speed of pumps **3.3 Positive Displacement pumps-**	**02** **04** **04**

	Types and applications, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram (no numerical on reciprocating pump). Use of air vessel (only application no numerical).	
4	**Air compressor-** Introduction and general classification of reciprocating compressor-positive displacement, Multi Staging of reciprocating compressor (no derivation, numerical on single stage and two stage compressor). Centrifugal compressor, surging and choking of compressor (No numerical on centrifugal compressor).	**04**
5	**Steam Turbine**- Basic of steam turbine, Classification, compounding of turbine, Impulse turbine –velocity diagram, Condition for max efficiency Reaction turbine, Numerical on Simple Impulse turbine (De-Laval turbine) of single stage only. Degree of reaction, Parson's turbine, Condition for maximum efficiency, Numerical on Parson's turbine only.	**06**
6	**6.1 Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio **6.2 Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency.	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text Books:-

1. Thermal Engineering, AjoyKumar,G. N Sah,Narosa Publishing House,New Delhi
2. Fluid Mechanics and Machinery; CSP Ojha, R. Berndtsson, Oxford University.
3. Fluid Mechanics and Fluid Machines by Gautam Biswas, S K Som, Suman Chakraborty - Tata McGraw-Hill Education Pvt. Ltd.
4. Turbines, Compressors and Fans by S.M. Yahya, McGraw-Hill Education Pvt. Ltd.

5. Turbomachinery Design and Theory by Aijaz and Gorla
6. Fluid Mechanics, thermodynamics of turbomachinery- S.L.Dixon,
7. Amsterdam; Boston: Elsevier-Butterworth-Heinemann

Reference Books:-

1. R.K.Rajput; Engineering Fluid Mechanics; S. Chand publications.
2. Dr. Mody& Seth; Hydraulics and Fluid Mechanics; Standard book house
3. S. Ramamrutham, Hydraulic, Fluid Mechanics & Fluid Machines, Dhanpat Rai publishing company.
4. Strecter, Fluid Mechanics, Tata McGraw Hill.
5. Thermal Engineering, R K. Rajput, Laxmi Publication
6. Fluid Mechanics: Fundamentals and application; Yunus A Cengel and John M CimbalaPublisher: Special India

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/106/112106303/ - Introduction to Turbomachines, IIT Madras
https://nptel.ac.in/courses/112/106/112106200/ - Fluid Dynamics and Turbomachines, IIT Madras

Course Code	Course Name	Credits
MEC603	**Heating,Ventilation,Air Conditioning and Refrigeration**	03

Objectives:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning
2. Study of various refrigeration cycles and evaluate performance of each cycle.
3. Study of components of refrigeration and air-conditioning systems along with the applications.

Outcomes: Learner will be able to…

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning systems.
2. Identify various HVAC&R components
3. .Evaluate performance of various refrigeration system
4. E stimate cooling and heating loads for an airconditioning system.
5. Select air handling unit & design air distribution system
6. Apply the knowledge of HVAC for the sustainable development of refrigeration and airconditioning systems.

Module	Details	Hrs
1.	**1.1 BasicKnowledge:**CarnotrefrigeratorCarnot h ,eat pumpCarnot,coefficient of performance,Reversed Carnot cycle,and its limitaionEffect of temperature and pressure on COP of the cycle **1.2 Refrigerants:** Classification,Designation,Selection of refrigerant,Physical and chemical pproperties of rrefrigerants ,Secondaryrrefrigerants **1.3 Air Refrigeration System:** Bell Coleman cycle, Necessity of air cooling, Factors considered for the selection of air refrigeration system, Types of air refrigeration system with schematic and T-Sdiagram, Numerical based on simple and bootstrap air refrigeration system.	**06**
2.	**2.1 VapourCompression Refrigeration System:** Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle, Numerical based on standard vapour compression system byusing P-h chart .and refrigerant table **2.2 Vapour Absorption Refrigeration System.** Simple and practical,vapour absorption systemRefrigerant-adsorbent properties, COP of ideal vapour absorption system, DomesticElectroluxrefrigerator, Lithiumbromideabsorption system. **2.3** :**Heat Pump** performance,Primary energy ratio,Energy efficiency Introduction,Coefficient of ratio,Heating season performance factor,Seasonal energy efficiency ,ratio,Classification of heat pump,Vapour compression heat pump systemsHeat pump application in an industry.	**08**

3.	**3.1 Thermal ComfortConditions:** Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions **3.2 Psychrometry:of Air Conditioning Processes** Psychrometry properties,relations and processes ,Adiabatic air mixing ,processPsychrometric chart,,RSHF,GSHF,ERSHF,Bypass factor ,Apparatus dew pointNumericalbased on psychrometric chart and .Classification of air conditioning system,relations **3.3 :Cooling Load Estimation** ,Introduction,Components of cooling loadDifferent heat sourcesV,arious load Estimation,Design of air conditioning systemBuilding survey and economic , aspect used in design.	**10**
4.	**4.1 Air DistributionSystem:** **4.1.1 :Duct** Classification of ducts,duct material, pressure in ductsF,low through duct, pressure losses in ductA,ir flow through simple duct systemE,quivalent diameter,Methods of duct system design: **4.1.2 :Air Handling Unit** ,oductionIntrFan coil unit, Types of fans used air conditioning applications, Fan lawsF,ilters,supply and return grills,Sensors.	**06**
5.	**5.1 HVACR& C:omponents** Working of reciprocating, screw and scroll compressors, working of air cooled, and water cooled andevaporative condensers, Working of DX, Flooded, and Forced feed evaporators, Expansion devices Capillary tube, TXV, EXV, Type of insulation materials.	**06**
6.	**6.1 Application of HVAC&R** Ice plant, Food storage plants, dairy and food processing plants, freeze drying, A/c in textile, Printing pharmaceutical industry and Hospitals ,Cold chain Technology, Transport air conditioning,Solar refrigeration.	**03**

Assessment:

- **Internal Assessment for 20 marks:**
  Consisting**Two Compulsory Class Tests**
  First test based onapproximately 40% of contentsand second test based onapproximately %40but excluding contents covered in Test I
- **End Semester Examination:**

1. Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
2. Question paper will comprise of total **six questions**, **each carrying 20 marks**
3. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
4. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. Only **Four questions need to be solved**

Text/Reference Books:-

1. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi
2. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi
3. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi
4. Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar, Dhanpatrai and sons, Delhi
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi
6. ISHRAE Air Conditioning Handbook
7. ISHRAE Refrigeration Handbook
8. ASHRAE Handbook of Fundamentals
9. ASHRAE Handbook of Equipment
10. ASHARE Handbook of System
11. Open Source Software/learning website

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/107/112107208/ - Refrigeration and Air Conditioning, IIT Roorkee
https://nptel.ac.in/courses/112/105/112105128/ - Refrigeration and Air Conditioning, IIT Kharagpur

Course Code	Course Name	Credits
MEC604	**Automation and Artificial Intelligence**	**03**

Objectives:

1. To understand the need and justification of automation.
2. To study design of pneumatic and hydraulic circuits.
3. To study and understand electropneumatic circuits and PLC Design
4. To familiarize with robotic systems in automated manufacturing processes.
5. To study and understand AI and machine learning technologies for automation.

Outcomes: Learner will be able to…

1. Demonstrate understanding of fundamentals of industrial automation and AI.
2. Design & develop pneumatic / hydraulic circuits.
3. Design and develop electropneumatic circuits and PLC ladder logics.
4. Demonstrate understanding of robotic control systems and their applications.
5. Demonstrate understanding of various AI and machine learning technologies.

Module	Details	Hrs
1	**1.1 Introduction to Automation** Definition and fundamentals of automation, Elements of Automated system, Automation principles and strategies, Levels of automation, types of automation, Advanced automation functions **1.2 Introduction to Artificial Intelligence** Introduction, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Mechanical Engineering	**04**
2	**2.1 Design of Pneumatic Circuits** Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 2 cylinders) **2.2 Design of Hydraulic Circuits** Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits.	**08**
3	**3.1 Electro-pneumatic Circuits** Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; **3.2 PLC Discrete Control Systems** Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.	**08**
4	**Robots and their applications**: Introduction to Robots, Types, Classifications, Selection of Robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a Robot, Robot feedback controls: Point to point control and Continuous path control, Control system for Robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications, Nex-gen robots.	**07**

5	**(Concept and Algorithms, No programming or numericals)** **5.1 Problem Solving:** Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound **5.2 Machine Learning:** Introduction, types of machine learning: supervised, unsupervised, reinforcement learning **5.3 Learning with Decision Trees:** Introduction to Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbours algorithm, hierarchical clustering, Concept of ensemble methods: bagging, boosting, random forests	**06**
6	**(Concept and Algorithms, No programming or numericals)** **6.1 Learning with regression:** Linear regression, Logistic regression **6.2 Artificial Neural Networks** Concept of ANN, Basic Models of Artificial Neural Networks Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, backpropagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions **6.3 Introduction to AI Technologies in the realm of Automation** Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
4. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Industrial Hydraulics: Pippenger

9. Vickers Manual on Hydraulics
10. Hydraulic Valves and Controls: Pippenger
11. Fundamentals of pneumatics: Festo series
12. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
13. Mechatronics, HMT
14. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education,New Delhi
15. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
16. Yoram Korean, "Robotics for engineers", McGrew Hill Co
17. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
18. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
19. Artificial Intelligence: A Modern Approach by Peter and Norvig ISBN-0-13103805-2,
20. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0-07008770-5, TMH,
21. Artificial Intelligence by Saroj KausikISBN:- 978-81-315-1099-5, Cengage Learning
22. Artificial Intelligence and Intelligent Systems by Padhy, Oxforfd University Press,
23. Artificial Intelligence & Machine Learning by Vinod Chandra .S.S. Anand Harindran. S. (PHI)
24. A first course in Artificial Intelligence – By Deepak Khemani. Mc GrawHill

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/103/112103174/

https://nptel.ac.in/courses/112/103/112103293/

https://nptel.ac.in/courses/112/102/112102011/

https://nptel.ac.in/courses/112/101/112101098/

https://nptel.ac.in/courses/112/103/112103280/

https://nptel.ac.in/courses/106/106/106106139/

Course Code	Course Name	Credit
MEDLO6021	**Press Tool Design**	**03**

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to….

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. understand safety aspects and automation in press working

Module	Details	Hrs
1	**Introduction to Press Working** 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Press working terminology, Functions of different elements of a press tool. material handling equipment, Methods of feeding the strip/coil material.	**6**
2	**Design Progressive die** 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, recommending minimum tonnage of a press, Methods of reducing cutting loads on press tools 2.2 Design aspects of Press tool elements viz. Punches & methods of mounting punches, types of Die block, Stripper, Pilot, stock guides, stock stops, Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools. 2.3 Centre of pressure, Different types Die sets and its selection, shut height of die, Problems based design of progressive die	**10**
3	**Bending and Drawing-** 3.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies, roller bending, bending force problems on bend length calculation and bending force, 3.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup, problems on drawing 3.3 Defects in drawn parts 3.4 Basic construction and working of Bending and Drawing dies	**8**

4	**Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies, Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies, drop through and inverted die, curling die, transfer die	4
5	**Selection of Presses and its setting** Classification of presses, Selection of Press and Press setting, calculation of shut press shut height and die shut height, Overloading of presses (load, energy considerations)	4
6	**Introduction to Automation & Safety in Press shop** Types of CNC Press, Types of CNC press controller, Basic hydraulic and pneumatic circuit used in press for stock feeding and ram movement, different types sensors used for hand protection, stock feeding etc., other safety equipment like break, clutch, face shield etc.	4

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credit
MEDLO6022	**Tool Engineering**	**03**

Objectives :

1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life, surface roughness and tool materials.
2. To familiarize with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to…

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyze heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyze economics of machining operations

Module	Details	Hrs
1	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model & modified model for orthogonal cutting, problems on above topic. 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gauge lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, piezoelectric dynamometry	**08**
2	2.1 **Temperatures in metal cutting and cutting fluids**: Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work tool thermocouple, direct thermocouple measurement, radiation methods, hardness changes in steel tools, Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, dry cutting and minimum quantity lubrication, cryogenic cooling, cutting fluid maintenance and environmental considerations, disposal of cutting fluids	**05**
3	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools, Techniques for manufacturing coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	**04**

4	**Tool life and Machining Economics**: 4.1 Definition, tool wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, machinability of material, factors affecting machinability, 4.2 Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate, problems on above topic.	**06**
5	**Design of single point cutting tools**: Different systems of tool nomenclature like MRS and ORS, Constructional features of solid tool, tipped tools, mechanically held regrindable insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders, Tool design for EDM and USM.	**05**
6	**Design of multi point cutting tools**: Introduction to various form tools, Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters, Drill, Reamer and Tap design using standard procedure.	**08**

Assessment:
Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow
8. Production Technology – HMT handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credits
MEDLO6023	**Metal FormingTechnology**	**03**

Objectives:

1. To conversant with the basic knowledge on fundamentals of metal formingprocesses
2. To study various metal formingprocesses
3. Understanding plastic deformation and technical analysis of forming processes

Outcomes: Learner will be able to…

1. Understand the concept of different metal formingprocess.
2. Approach metal forming processes both analytically andnumerically
3. Design metal formingprocesses
4. Develop approaches and solutions to analyze metal forming processes and the associated problems andflaws.

Module	Details	Hrs
1.	**Introduction to Metal Forming:** Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, effects of temperature, strain rate, microstructure and friction in metal forming-yield criteria and their significance, Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, deformation mechanisms, Hot and Cold Working Processes and Its Effect on MechanicalProperties.	**08**
2.	**Rolling:** Introduction and Classification, Types of Rolling Mills, Forces andGeometrical Relationships in Rolling, Calculation of Rolling Load, Roll Pass Design, and Defects in Rolled Products.	**07**
3.	**Forging:** Introduction and Classification, operation and principle of Forging Processes and Equipment, Methods of forging, Open and Close Die Forging Processes, Defects, Structure and Properties of Forged Products. Force Analysis inforging.	**07**
4.	**Extrusion:** Introduction and Classification, Extrusion Equipment, Forces inextrusion, Analysis of Extrusion Process, Extrusion of components including Seamless Pipes and Tubes. Extrusion of pipes by cold working,	**06**
5.	**Drawing:** Introduction and Classification, Wire Drawing, Rod Drawing, Tube Drawing, Deep Drawing, Analysis of Wire Drawing Process and Load Calculations.	**06**
6.	**Sheet Metal Forming:** Principle, process parameters, equipment and application of the following processes: spinning, stretch forming, plate, V and edge bending, Curling, Ironing, Roll Bending, Metal Spinning. Press brake forming, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming.High Velocity forming of metals and High energy Rate forming	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books: -

1. Lin D Balint M Pietrzyk, Microstructure Evolution in Metal Forming Processes 1st Edition
2. Amitabha Ghosh and Asok Kumar Mallick, Manufacturing Science, Affiliated East-West Press
3. Christian Brecher and Ozdemir , Advances in Production Technology, Springer Publications
4. P.C.Sharma , A Text Book on Production Engineering, S.Chand Publications
5. P. N. Rao, "Manufacturing Technology", Tata McGraw Hill
6. Aviter, "Fundamental of Metal Working", McGraw Hill Publisher
7. Dieter, "Mechanical Metallurgy"

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/107/112107250/ - Principles of Metal Forming Technology, IIT Roorkee

https://nptel.ac.in/courses/112/106/112106153/ - Forming, IIT Madras

Course Code	Course Name	Credits
MEL601	**Machine Design**	**01**

Objectives:

1. To study the basic of modelling software, part design and assembly making.
2. To familiarize with use of design data books & various codes of practice.
3. Based on design calculation preparation of working drawings of actual design model.

Outcomes: Learner will be able to…

1. Design shaft under various conditions
2. Design Knuckle Joint / cotter joint
3. Design Screw Jack
4. Design Flexible flange couplings/ Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardise the designed dimensions.

Term Work:

a) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on A3 size sheets.

1) Knuckle Joint / cotter joint
2) Couplings
3) Screw Jack
4) Leaf springs

Software Analysis of any one component from the above list

b) Assignments:

Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

1) Bolted and welded joints
2) Bearings.
3) Shaft design (solid and hollow shaft)
4) Flywheel and Belts.

The distribution of marks for term work shall be as follows:

Assignments, Exercises& Drawing sheets:	15 Marks
Course Project:	05 Marks (Minimum five components)
Attendance:	05 Marks

End Semester Practical/Oral examination:

1. Each student will be given a small task of design, based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task.
4. Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas& Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts.

Course Code	Course Name	Credits
MEL602	**Turbo Machinery**	**01**

Objectives

1. To familiarize with boilers, boiler mountings and accessories using models/cut sections.
2. To familiarize with hydraulic energy conversion devices.
3. To familiarize with thermal energy conversion devices.

Outcomes: Learner will be able to…

1. Differentiate boiler, boiler mountings and accessories
2. Conduct a trial on reciprocating compressor / centrifugal compressor.
3. Conduct a trial on impulse turbine and analyze its performance
4. Conduct a trail on reaction turbine and analyze its performance
5. Conduct a trial on Centrifugal pump and analyze its performance
6. Conduct a trial on Reciprocating pump and analyze its performance
7. Conduct a trial on gear pump

List of Experiments

Group-A (conduct any 7 including S.N.10)

1. Demonstration / e-learning of Boiler, Boiler mountings and accessories
2. Impact of jet
3. Trial on Impulse turbine (Pelton Wheel Turbine)
4. Trial on Reaction turbine (Francis Turbine)
5. Trial on Reaction turbine (Kaplan Turbine)
6. Trial on centrifugal pump (Single stage/Multistage)
7. Trial on reciprocating pump.
8. Trial on reciprocating / centrifugal air compressor
9. Trial on gear pump
10. Industrial visit to a power plant (compulsory)

Group –B (conduct any 3)

1. Measurement of Hydrostatic Pressures
2. Verification of Archimedes' Principle
3. Calibration of Venturimeter/ Orifice meter/Nozzle/ Pitot tube
4. Determination the friction factor in Pipes
5. Determination of major and minor losses in Pipe systems
6. Verification of Bernoulli's Equation
7. Calculation of Lift and Drag over an aerofoil

Assessment:

Term Work

Term work shall consist of all the experiments from the list, 3 assignments containing numerical based on Centrifugal Pump, Reciprocating Pump and centrifugal compressor and a visit report.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments): 10 marks
- Assignments: 05 marks
- Visit report: 05 Marks
- Attendance: 05 marks

Virtual Labs

http://fm-nitk.vlabs.ac.in/# - Fluid Mechanics Lab, NITK Surathkal

https://fmc-nitk.vlabs.ac.in/fluid-machinery/ - Fluid Machinery Lab, NITK Surathkal

Course Code	Course Name	Credits
MEL603	**Heating, Ventilation, Air Conditioning and Refrigeration**	01

Objectives:

1. To study working and operating principle of vapour Compression and vapour absorption system.
2. To study Controls and Components of refrigeration and Airconditioning system.
3. To design air conditioning systems using cooling load calculation.

Outcomes: Learner will be able to…

1. **Aware** of the roles and ethics of HVAC &R engineers in related industries.
2. **Present** the impact of professional engineering solutions in societal and environmental contexts.
3. performance of HVAC &R systems **Evaluate**
4. **Develop** awareness of the engineering and technological aspects in the HVAC &R industries.
5. **Communicate** effectively through the preparation ofreport and practical presentation**.**
6. **Analyse** design aspectsof HVAC&R invarious.application

A -Part

List of Experiments

1. Study and performance on simple vapour compressiontest rig .
2. Study and performance of .heat pump test rig
3. Trial on Vapour absorbtion refrigerationtest rig.
4. Perform humidification anddehumdification air conditioning process on air .conditioning test rig
5. Study and performance of cooling tower based on the cooling load and approach to wet bulb temperature.
6. Study and performance of refrigeration cycle on Ice plant.
7. Performance analysis on watercooler system .
8. Cooling capacityanalysis of the desertcooler.
9. Steady state Simulation of VCR system with developed code or any analytical software.
10. Calculate cooling load of a confined space.

Part -B

/Case studies through Seminar Poster presentation on

1. Chiller unit
2. Building Management system(Introduction)
3. Effect on Ozone depletion andGlobal warming,
4. Alternative Refrigerants.
5. Refrigerant Different Protocols used in
6. Variable refrigerant flow technology & its smart control

Term Work

Term work shall consist of

1. Minimumsix experiments
2. Industrial visit on any HVAC &R plant
3. Case study report

Distribution:of Term work marks as follow

1. Experiments : 10 marks
2. Case study :5 marks
3. Industrial Visit Report : 5 Marks
4. Attendance (Theory + Practical) : 5 marks

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Practical examination (in a group of not more than 5 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:
    a. Practical performance ……**15** marks
    b. Oral …… ………………**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. .Evaluation of oral examination to be done based on the entire syllabus
6. Students work along with evaluation report to be preserved till the next examination

Virtual Labs

http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/refigeration/index.php - Refrigeration and Air Conditioning Virtual Lab, IIT Bombay

Course Code	Course Name	Credits
MESBL601	**Measurements and Automation**	**02**

Objectives:

1. To study fundamentals of inspection methods and systems.
2. To study working of mechanical measurement system.
3. To familiarise with different types of control systems.
4. To study different hydraulic and pneumatic systems.
5. To study various design principles of robotics through kinematic analysis, workspace analysis and trajectory planning.

Outcomes: Learner will be able to…

1. Apply inspection gauge to check or measure surface parameters.
2. Measure surface parameters using precision measurement tools and equipment.
3. Measure different mechanical parameters by using sensors.
4. Analyse the response of a control systems.
5. Demonstrate use of automated controls using pneumatic and hydraulic systems.
6. Implement program on PLC system and demonstrate its application

The laboratory experiments should be based on the following:

Group A (Metrology):

1. Experiments on linear and angular measurement using Vernier calliper, micrometer and Bevel protractor.
2. Experiments on surface measurement by using Surface roughness tester.
3. Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester.
4. Experiments on screw thread measurement using screw thread micrometer, Floating carriage micrometer / bench micrometer.
5. Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector or Tool maker's microscope.
6. Experiment using Mechanical / Pneumatic type Comparator.
7. Experiments on flatness measurement by Autocollimator / Interferometry method

Group B (Mechanical Measurement):

1. Experiments on measurement of displacement by sensors like LVDT, Potentiometers etc.
2. Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc.
3. Experiments on measurement of vibration by accelerometers or NI.
4. Experiments on feedback control systems and servomechanisms
5. Experiment on frequency response system identification / transient state response of a control system.
6. Experiment on design of PID controller for a system or simulate and tune a PID controller using lab view.

Group C (Automation):

1. Experiment on trainer kit (Any one)

a) Designing sequential operation for two cylinders using electro-hydraulic circuits.

or

b) Designing sequential operation for two cylinders using electro- pneumatic circuits.

2. Experiment on simulation using software like Festo, AutoSim etc.

a) Simulation of basic pneumatic and electro-pneumatic circuits.

or

b) Simulation of hydraulic and electro-hydraulic circuits.

3. Experiments on Ladder programming

a) Experiments on Ladder programming on PLC for simple ON OFF control, timers, counter, two motor system, simple control applications with logic/ timers/counters.

or

b) Experiments on Ladder programming for Mechatronics system (e.g. bottle filling plant, control of electro-pneumatic or electro-hydraulic systems).

4. Experiments on Robotics

a) Demonstration and study of functions of components of robotics arm.

or

b) Visualization of DH (Denavit–Hartenberg) parameters in Roboanalyzer (*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com).

Term Work

Term work shall consist of minimum Nine Experiments. Three from each group mentioned above. There will be no theoretical assignment for the lab course. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 20 marks
Attendance: : 05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical and viva based on contents.
2. Practical examination (in a group of not more than 4 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:

Practical performance: 15 marks
Oral: 10 marks

4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.
5. Students work along with evaluation report to be preserved till the next examination.

Virtual Labs

http://ial-coep.vlabs.ac.in/ - Industrial Automation Laboratory, COEP

Course code	Course Name	Credits
MEPBL601	**Mini Project - 2B**	**02**

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

University of Mumbai

No. AAMS(UG)/84 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings and Services which was accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No. 4.180 relating to the revised syllabus as per the (CBCS) for Information Technology (Sem III to VIII).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Information Technology at its meeting held on 3rd May, 2021 and subsequently passed by the Board of Deans at its meeting held on 11th June, 2021 vide item No. 6.12 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 6.12 (R) and that in accordance therewith, the revised syllabus (Rev -2019 'C' Scheme) for the B.E. in Information Technology (T.E.- Sem. V and VI) has been brought into force with effect from the academic year 2021-22 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
30th September, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.12 (R) 29/06/2021

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No. AAMS(UG)/ 84 -A of 2021-22 MUMBAI-400 032 30th September, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Information Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC: 29/6/2021

Item No. : 6.12

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology

Third Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 29/6/2021
Item No. 6.12

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year Bachelor of Information Technology**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	**Under Graduation**
7	Pattern	**Semester**
8	Status	**Revised**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date : 29/6/2021

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By Board of Studies Team

It is our honor and a privilege to present the Rev-2019 ‘C’ scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)

Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Third Year Information Technology

Semester V & VI

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract.**	**Theory**	**Pract.**	**Total**
ITC501	Internet Programming	3	--	3	--	3
ITC502	Computer Network Security	3	--	3		3
ITC503	Entrepreneurship and E-business	3	--	3	--	3
ITC504	Software Engineering	3	--	3	--	3
ITDO501X	**Department Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL501	IP Lab	--	2	--	1	1
ITL502	Security Lab	--	2	--	1	1
ITL503	DevOPs Lab	--	2	--	1	1
ITL504	Advance DevOPs Lab	-	2	--	1	1
ITL505	Professional Communication & Ethics-II (PCE-II)	--	2*+2	--	2	2
ITM501	Mini Project – 2 A Web Based Business Model	--	$4^{\$}$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC501	Internet Programming	20	20	20	80	3	--	--	100
ITC502	Computer Network Security	20	20	20	80	3	--	--	100
ITC503	Entrepreneurship and E-business	20	20	20	80	3	--	--	100
ITC504	Software Engineering	20	20	20	80	3	--	--	100
ITDO501X	**Department Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL501	IP Lab	--	--	--	--	--	25	25	50
ITL502	Security Lab	--	--	--	--	--	25	25	50
ITL503	DevOPs Lab	--	--	--	--	--	25	25	50

ITL504	Advance DevOPs Lab	--	--	--	--	--	25	25	50
ITL505	Professional Communication & Ethics-II (PCE-II)	--	--	--	--	--	50	--	50
ITM501	Mini Project – 2 A Web Based Business Model	--	--	--	--	--	25	25	50
Total		--	--	**100**	**400**	--	**175**	**125**	**800**

* Theory class to be conducted for full class

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO501X	**Department Optional Course – 1**
ITDO5011	Microcontroller Embedded Programming
ITDO5012	Advance Data Management Technologies
ITDO5013	Computer Graphics & Multimedia System
ITDO5014	Advanced Data structure and Analysis

Program Structure for Third Year Information Technology
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC601	Data Mining & Business Intelligence	3	--	3	--	3
ITC602	Web X.0	3	--	3		3
ITC603	Wireless Technology	3	--	3	--	3
ITC604	AI and DS – 1	3	--	3	--	3
ITDO601 X	**Department Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL601	BI Lab	--	2	--	1	1
ITL602	Web Lab	--	2	--	1	1
ITL603	Sensor Lab	--	2	--	1	1
ITL604	MAD & PWA Lab	--	2	--	1	1
ITL605	DS using Python Skill based Lab	--	2	--	1	1
ITM601	Mini Project – 2 B Based on ML	--	4$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100
ITC602	Web X.0	20	20	20	80	3	--	--	100
ITC603	Wireless Technology	20	20	20	80	3	--	--	100
ITC604	AI and DS – 1	20	20	20	80	3	--	--	100
ITDO601 X	**Department Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL601	BI Lab	--	--	--	--	--	25	25	50
ITL602	Web Lab	--	--	--	--	--	25	25	50
ITL603	Sensor Lab	--	--	--	--	--	25	25	50
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50
ITL605	DS using Python Lab (SBL)	--	--	--	--	--	25	25	50

ITM601	Mini Project – 2 B Based on ML	--	--	--	--	--	25	25	50
Total		--	--	**100**	**400**	--	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO601X	**Department Optional Course – 2**
ITDO6011	Software Architecture
ITDO6012	Image Processing
ITDO6013	Green IT
ITDO6014	Ethical Hacking and Forensic

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITC501	Internet Programming	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test2**	**Avg.**					
ITC501	Internet Programming	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To orient students to Web Programming fundamental.
2	To expose students to JavaScript to develop interactive web page development
3	To orient students to Basics of REACT along with installation
4	To expose students to Advanced concepts in REACT
5	To orient students to Fundamentals of node.js
6	To expose students to node.js applications using express framework.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Select protocols or technologies required for various web applications.	L1,L2,L3,L4
2	Apply JavaScript to add functionality to web pages.	L1, L2, L3
3	Design front end application using basic React.	L1,L2,L3,L4,L5,L6
4	Design front end applications using functional components of React.	L1,L2,L3,L4,L5,L6
5	Design back-end applications using Node.js.	L1,L2,L3,L4,L5,L6
6	Construct web based Node.js applications using Express.	L1,L2,L3,L4,L5,L6

Prerequisite: Knowledge of basic programming, network fundamentals and operating systems.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Introduction and basics of HTML, CSS	**02**	-
I	Web programming fundamentals	Working of web browser, HTTP protocol, HTTPS, DNS, TLS, XML introduction, Json introduction, DOM, URL, URI, REST API. **Self-learning Topics:** : Nginx server	**03**	CO1
II	Java script:	Introduction to ES6, Difference between ES5 and ES6. Variables, Condition, Loops, Functions, Events, Arrow functions, Setting CSS Styles using JavaScript, DOM manipulation, Classes and Inheritance. Iterators and Generators, Promise, Client-server communication, Fetch **Self-learning Topics:** Asynchronous JavaScript, JSON	**06**	CO2
III	React fundamentals	Installation, Installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices. **Self-learning Topics**: React vs Angular vs Vue	**07**	CO3
IV	Advanced React:	Functional components- Refs, Use effects, Hooks, Flow architecture, Model-View-Controller framework, Flux, Bundling the application. Web pack. **Self-learning Topics:** React Native	**07**	CO4
V	Node.js:	Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module. **Self-learning Topics:** Node.js with Mongodb.	**07**	CO5
VI	Express:	Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React. **Self-learning Topics:** Commercial deployment.	**07**	CO6

Text Books:

1. Rediscovering JavaScript, Master ES6, ES7, and ES8, By Venkat Subramaniam · 2018
2. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly
3. Learning Redux, Daniel Bugl, Packt Publication
4. Learning Node.js Development, Andrew Mead, Packt Publishing
5. RESTful Web API Design with Node.js 10, Valentin Bojinov, Packt Publication

References:

1. Web Development with Node and Express, Ethan Brown, O'Reilly

Online Resources:

2. https://reactjs.org/tutorial/tutorial.html
3. https://react-redux.js.org/introduction/quick-start
4. https://webpack.js.org/
5. https://www.youtube.com/watch?v=-27HAh8c0YU

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITC502	Computer Network Security	03	--	03	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test2**	**Avg.**					
ITC502	Computer Network Security	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The basic concepts of computer and Network Security
2	Various cryptographic algorithms including secret key management and different authentication techniques.
3	Different types of malicious Software and its effect on the security.
4	Various secure communication standards including IPsec, SSL/TLS and email.
5	The Network management Security and Network Access Control techniques in Computer Security.
6	Different attacks on networks and infer the use of firewalls and security protocols.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamentals concepts of computer security and network security.	L1, L2
2	Identify the basic cryptographic techniques using classical and block encryption methods.	L1
3	Study and describe the system security malicious software.	L1, L2
4	Describe the Network layer security, Transport layer security and application layer security.	L1, L2
5	Explain the need of network management security and illustrate the need for NAC.	L1, L2
6	Identify the function of an IDS and firewall for the system security.	L1,L2, L3

Prerequisite: Basic concepts of Computer Networks & Network Design, Operating System

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DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic concepts of Computer Networks & Network Design, Operating System	**02**	--
I	Introduction to Network Security & cryptography	Computer security and Network Security(Definition), CIA, Services, Mechanisms and attacks, The OSI security architecture, Network security model. Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, transposition techniques: keyed and keyless transposition ciphers). Introduction to steganography. **Self-learning Topics:** Study some more classical encryption techniques and solve more problems on all techniques. Homomorphic encryption in cloud computing	**07**	CO1
II	Cryptography: Key management, distribution and user authentication	Block cipher modes of operation,Data Encryption Standard, Advanced Encryption Standard (AES). RC5 algorithm. Public key cryptography: RSA algorithm. Hashing Techniques: SHA256, SHA-512, HMAC and CMAC, Digital Signature Schemes – RSA, DSS. Remote user Authentication Protocols, Kerberos, Digital Certificate: X.509, PKI **Self-learning Topics:** Study working of elliptical curve digital signature and its benefits over RSA digital signature.	**09**	CO2
III	Malicious Software	SPAM, Trojan horse, Viruses, Worms, System Corruption, Attack Agents, Information Theft, Trapdoor, Keyloggers, Phishing, Backdoors, Rootkits, Denial of Service Attacks, Zombie **Self-learning Topics:** Study the recent malicious software's and their effects.	**04**	CO3
IV	IP Security, Transport level security and Email Security	IP level Security: Introduction to IPSec, IPSec Architecture, Protection Mechanism (AH and ESP), Transport level security: VPN. Need Web Security considerations, Secure Sockets Layer (SSL)Architecture, Transport Layer Security (TLS), HTTPS, Secure Shell (SSH) Protocol Stack. Email Security: Secure Email S/MIME Screen reader support enabled. **Self-learning Topics:** Study Gmail security and privacy from Gmail help	**07**	CO4
V	Network Management Security and Network Access Control	Network Management Security:SNMPv3, NAC:Principle elements of NAC,Principle NAC enforcement methods, How to implement NAC Solutions, Use cases for network access control **Self-learning Topics:** Explore any open source network management security tool	**06**	CO5

VI	System Security	IDS, Firewall Design Principles, Characteristics of Firewalls, Types of Firewalls **Self-learning Topics:** Study firewall rules table	**04**	CO6

Textbooks:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013.
2. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
3. Mark Stamp's Information Security Principles and Practice, Wiley
4. Bernard Menezes, "Cryptography & Network Security", Cengage Learning.

References:

1. Applied Cryptography, Protocols, Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.
3. www.rsa.com

Online References:

Sr. No.	Website Name
1.	https://swayam.gov.in/
2.	https://nptel.ac.in/
3.	https://www.coursera.org/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITC503	Entrepreneurship and E-business	03	--	03	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test2**	**Avg.**					
ITC503	Entrepreneurship and E-business	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Distinguish Entrepreneur and Entrepreneurship starting and feasibility study.
2	Realize the skills required to be an entrepreneur
3	Acquaint the students with challenges of starting new ventures
4	Identify the right sources of fund for starting a new business
5	Be familiarized with concept of E-business Models.
6	Understand various E-business Strategies.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of entrepreneurship and its close relationship with enterprise and owner-management.	L1,L2
2	Understand the nature of business development in the context of existing organizations and of new business start-ups.	L1,L2
3	Comprehended important factors for starting a new venture and business development.	L1,L2,L3
4	Know issues and decisions involved in financing and resourcing a business start-up	L1,L2,L3,L4
5	Describe various E-business Models	L1,L2,L3,L4
6	Discuss various E-business Strategies.	L1,L2,L3,L4

Prerequisite: None

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**None**	--	--
I	Introduction	Concept, meaning and definition of Entrepreneur and Entrepreneurship. Evolution of Entrepreneurship, Role of Entrepreneurship in economic Development; Managerial vs entrepreneurial approach; Classification and types of Entrepreneurs. Characteristics and qualities of successful Entrepreneurs; Women Entrepreneurs; Corporate & Social entrepreneurship. **Self-learning Topics:** Factors impacting emergence of entrepreneurship.	**04**	CO1
II	Entrepreneurship Development and Leadership	Entrepreneurial Motivation: motivating factors, Types of startups; Characteristics of entrepreneurial leadership, Components of Entrepreneurial Leadership; Factors influencing entrepreneurial development and motivation, Entrepreneurial Opportunities and challenges, Entrepreneurship process. Types of Enterprises and Ownership Structure: small scale, medium scale and large-scale enterprises: Meaning and definition (evolution), role of small enterprises in economic development; proprietorship, Policies governing SMEs, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance. **Self-learning Topics:** study the white paper https://www.ncert.nic.in/ncerts/l/lebs213.pdf	**06**	CO2
III	New Venture Planning	Methods to Initiate Ventures; Acquisition-Advantages of acquiring an ongoing venture and examination of key issues; Developing a Marketing plan-customer analysis, sales analysis and competition analysis, Business Plan-benefits of drivers, perspectives in business plan preparation, elements of a business plan; Business plan failures. **Self-learning Topics:** Refer following URL to study various case studies https://www.entrepreneurindia.co/case-studies	**07**	CO3
IV	Financing & Managing Venture	Financing Stages; Sources of Finance; Venture Capital; Criteria for evaluating new-venture proposals & Capital-process. Management of venture: objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection **Self-learning Topics:** visit website	**06**	CO4

		https://www.startupindia.gov.in		
V	Overview of E – business	Concept of E-business, Business Success through adoption of technology, information management for business Initiatives, Performance improvement through e-business. Introduction to various collaborative partnerships, E-commerce: Sectors of e-commerce, B to C, B to B and C to C ecommerce, E-commerce success factors, clicks and Bricks in ecommerce, collaborative commerce. E-Marketplace, M-commerce, E-Government; Various E-business Models, Challenges of the E-Business Models, Globalization of E-business. **Self-learning Topics:** Social media applications for E-Business, Social media analytics.	**08**	CO5
VI	Strategic Initiatives for Technology	**Customer Relationship Management:** The evolution of CRM, functional areas of CRM, contemporary trends - SRM, PRM AND ERM, Future Trends of CRM **Enterprise Resource Planning**: Core and Extended ERP; components of ERP system; Benefits and Risks of ERP implementation **Supply Chain Management**: Meaning, definition, importance, and characteristics of SCM, Elements of SCM, Push & Pull supply chain model, Use of e-business to restructure supply chain, Supply chain management implementation **Procurement**: Meaning and advantages of e –procurement, Types& Drivers of e- procurement, Components of e-procurement systems, Implementation of e-procurement **Self-learning Topics:** SEM and SEO E-CRM	**08**	CO6

Textbooks:

1 Entrepreneurship; Robert Hisrich, Michael Peters; Tata McGraw Hill Publication
2 Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
3 E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education
4 E-commerce – A Managerial Perspective- P. T. Joseph, Prentice Hall India Publications. Content

References:

1 Entrepreneurship and Innovations in E-business An Integrative Perspective by Fang Zhao, Idea Group Publications.
2 Business Driven Technology –Haag/Baltzan/Philips –Tata McGraw Hill Publication
3 Digital Business and E-commerce Management by Dave Chaffey, David Edmundson-Bird, Tanya Hemphill, Pearson Education
4 E-Business 2.0 Roadmap for Success by Dr. Ravi Kalakota, Marcia Robinson, Pearson Education
5 Case Studies in International Entrepreneurship: Managing and Financing Ventures in the Global Economy. By Walter Kuemmerle, Walter Kuemmerle. McGraw-Hill/Irwin, 2004.

ISBN: 0072977841.

Note: - It is advisable that faculty should discuss case studies in the classroom

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITC504	Software Engineering	03	--	03	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract/ Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITC504	Software Engineering	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide the knowledge of software engineering discipline.
2	To understand Requirements and analyze it
3	To do planning and apply scheduling
4	To apply analysis, and develop software solutions
5	To demonstrate and evaluate real time projects with respect to software engineering principles
6	Apply testing and assure quality in software solution.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand and use basic knowledge in software engineering.	L1, L2
2	Identify requirements, analyze and prepare models.	L1, L2, L3
3	Plan, schedule and track the progress of the projects.	L1, L2, L3
4	Design & develop the software solutions for the growth of society	L1, L2, L3
5	To demonstrate and evaluate real time projects with respect to software engineering principles	L1, L2, L3, L4
6	Apply testing and assure quality in software solution	L1, L2, L3, L4

Prerequisite: Basic programming of knowledge.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	None	--	--
I	Introduction to Software Engineering	Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM) Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model **Self-learning Topics:** Personal and Team Process Models	**06**	CO1,CO2
II	Requirement Analysis	Software Requirements: Functional & non-functional – user-system requirement engineering process – feasibility studies – elicitation – validation & management – software prototyping – S/W documentation – Analysis and modelling Requirement Elicitation, Software requirement specification (SRS), **Self-learning Topics:** prioritizing requirements (Kano diagram) - real life application case study.	**07**	CO1,CO2
III	Software Estimation and Scheduling	Management Spectrum, 3Ps (people, product and process) Process and Project metrics Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model, Specialized Estimation Techniques, Object based estimation, use-case based estimation Project scheduling: Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule, Earned Value Analysis **Self-learning Topics:** Cost Estimation Tools and Techniques, Typical Problems with IT Cost Estimates.	**06**	CO3
IV	Design Engineering	Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. 4.2 Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design	**07**	CO3, CO4

		steps & Analysis, Design Evaluation **Self-learning Topics:** Refinement, Aspects, Refactoring		
V	Software Risk, Configuration Management	Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough **Self-learning Topics:**: Configuration management for WebApps	**07**	CO5
VI	Software Testing and Maintenance	Testing: Software Quality, Testing: Strategic Approach, Strategic Issues- Testing: Strategies for Conventional Software, Object oriented software, Web Apps-Validating Testing- System Testing- Art of Debugging. Maintenance : Software Maintenance-Software Supportability- Reengineering- Business Process Reengineering- Software Reengineering- Reverse Engineering- Restructuring- Forward Engineering **Self-learning Topics:** Test Strategies for WebApps	**06**	CO6

Text Books:

1 Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill
2 Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
3 PankajJalote, An integrated approach to Software Engineering, Springer/Narosa.
4 Ian Sommerville, Software Engineering, Addison-Wesley.

References:

1 https://nptel.ac.in/courses/106/101/106101061/
2 https://www.youtube.com/watch?v=wEr6mwquPLY
3 http://www.nptelvideos.com/video.php?id=911&c=9
4 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=66
5 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=67
6 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=65
7 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=64
8 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=63

Preferable: Case studies can be discussed on every unit as per requirement for better understanding, examples are given below.

Unit 1	An information system (mental health-care system), wilderness weather system.
Unit 2	Mental health care patient management system (MHC-PMS).
Unit 3	Software Tools for Estimation.

Unit 4	Risk management in Food delivery software.
Unit 5	Study design of Biometric Authentication software.
Unit 6	Selenium Testing with any online application.

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL501	IP Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL501	IP Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To orient students to HTML for making webpages
2	To expose students to CSS for formatting web pages
3	To expose students to developing responsive layout
4	To expose students to JavaScript to make web pages interactive
5	To orient students to React for developing front end applications
6	To orient students to Node.js for developing backend applications

Lab Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and apply the appropriate HTML tags to develop a webpage.	L1, L2,L3,L4
2	Identify and apply the appropriate CSS tags to format data on webpage	L1, L2,L3,L4
3	Construct responsive websites using Bootstrap	L1, L2,L3,L4,L5,L6
4	Use JavaScript to develop interactive web pages.	L1, L2,L3,L4,L5,L6
5	Construct front end applications using React	L1, L2,L3,L4,L5,L6
6	Construct back end applications using Node.js/Express	L1, L2,L3,L4,L5,L6

Prerequisite: Knowledge of Java programming and object-oriented programming.

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above	Google Chrome Browser (latest), Java 8 or above, NodeJS, React. Internet Connection

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	HTML5	Elements, Attributes, Head, Body, Hyperlink, Formatting, Images, Tables, List, Frames, Forms, Multimedia	**02**	LO1
II	CSS3	Syntax, Inclusion, Color, Background, Fonts, Tables, lists,CSS3 selectors, Pseudo classes, Pseudo elements	**02**	LO2
III	Bootstrap	Grid system, Forms, Button, Navbar, Breadcrumb, Jumbotron	**02**	LO3
IV	JavaScript	Variables, Operators, Conditions, Loops, Functions, Events, Classes and Objects, Error handling, Validations, Arrays, String, Date	**05**	LO4
V	React	Installation and Configuration. JSX, Components, Props, State, Forms, Events, Routers, Refs, Keys.	**08**	LO5
VI	Node.js	Installation and Configuration, Callbacks, Event loops, Creating express app.	**07**	LO6

Textbooks:

1. HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery) 2Ed., DT Editorial Services
2. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O’Reilly
3. Learning Node.js Development, Andrew Mead, Packt Publishing

References:

1. https://www.tutorialspoint.com/
2. https://reactjs.org/tutorial/tutorial.html
3. https://nodejs.dev/learn
4. https://www.youtube.com/watch?v=-27HAh8c0YU

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL502	Security Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL502	Security Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To apply the knowledge of symmetric cryptography to implement classical ciphers.
2	To analyze and implement public key encryption algorithms, hashing and digital signature algorithms.
3	To explore the different network reconnaissance tools to gather information about networks.
4	To explore the tools like sniffers, port scanners and other related tools for analyzing.
5	To Scan the network for vulnerabilities and simulate attacks.
6	To set up intrusion detection systems using open-source technologies and to explore email security.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Illustrate symmetric cryptography by implementing classical ciphers.	L1,L2
2	Demonstrate Key management, distribution and user authentication.	L1,L2
3	Explore the different network reconnaissance tools to gather information about networks	L1,L2, L3
4	Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.	L1,L2,L3
5	Use open-source tools to scan the network for vulnerabilities and simulate attacks.	L1,L2,L3
6	Demonstrate the network security system using open source tools.	L1,L2

Prerequisite: Basic concepts of Computer Networks & Network Design, Operating System

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. wireshark 3. ARPWATCH 4. Kismet, NetStumbler 5. NESSU

DETAILED SYLLABUS:

Sr. No.	Detailed Content	Hours	LO Mapping
I	Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher)	**04**	LO1
II	1)Block cipher modes of operation using a)Data Encryption Standard b)Advanced Encryption Standard (AES). 2)Public key cryptography: RSA algorithm. 3)Hashing Techniques: HMAC using SHA 4)Digital Signature Schemes – RSA, DSS.	**06**	LO2
III	1) Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars. 2) Study of packet sniffer tools Wireshark, :- a. Observer performance in promiscuous as well as non-promiscuous mode. b. Show the packets can be traced based on different filters.	**04**	LO3
IV	1) Download and install nmap. 2) Use it with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.	**04**	LO4
V	a) Keylogger attack using a keylogger tool. b) Simulate DOS attack using Hping or other tools c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities.	**04**	LO5
VI	1) Set up IPSec under Linux. 2) Set up Snort and study the logs. 3) Explore the GPG tool to implement email security	**04**	LO6

Text Books

1 Build your own Security Lab, Michael Gregg, Wiley India.
2 CCNA Security, Study Guide, TIm Boyles, Sybex.
3 Hands-On Information Security Lab Manual, 4th edition, Andrew Green, Michael Whitman,

Herbert Mattord.

4 The Network Security Test Lab: A Step-by-Step Guide Kindle Edition, Michael Gregg.

References:

1 Network Security Bible, Eric Cole, Wiley India.
2 Network Defense and Countermeasures, William (Chuck) Easttom.
3 Principles of Information Security + Hands-on Information Security Lab Manual, 4th Ed. , Michael E. Whitman , Herbert J. Mattord.
4 IITB virtual Lab: http://cse29-iiith.vlabs.ac.in/
5 https://www.dcode.fr/en

Sr.No	Experiment Title
1.	Breaking the Mono-alphabetic Substitution Cipher using Frequency analysis method.
2.	Design and Implement a product cipher using Substitution ciphers.
3.	Cryptanalysis or decoding Playfair, vigenere cipher.
4.	Encrypt long messages using various modes of operation using AES or DES.
5.	Cryptographic Hash Functions and Applications (HMAC): to understand the need, design and applications of collision resistant hash functions.
6.	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA.
7.	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
8.	Study of packet sniffer tools wireshark: - a. Observer performance in promiscuous as well as non-promiscuous mode. b. Show the packets can be traced based on different filters.
9.	Download, install nmap and use it with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.
10.	Study of malicious software using different tools: a) Keylogger attack using a keylogger tool. b) Simulate DOS attack using Hping or other tools c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities.
11.	Study of Network security by a) Set up IPSec under Linux. b) Set up Snort and study the logs. c) Explore the GPG tool to implement email security

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL503	DevOPs Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL503	DevOPs Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand DevOps practices which aims to simplify Software Development Life Cycle
2	To be aware of different Version Control tools like GIT, CVS or Mercurial
3	To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment
4	To be familiarized with selenium tool, which is used for continuous testing of applications deployed.
5	To use Docker to Build, ship and manage applications using containerization
6	To understand the concept of Infrastructure as a code and install and configure Ansible tool.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirements	L1,L2
2	To obtain complete knowledge of the "version control system" to effectively track changes augmented with Git and GitHub	L1,L2
3	To understand the importance of Jenkins to Build and deploy Software Applications on server environment	L1,L2
4	Understand the importance of Selenium and Jenkins to test Software Applications	L1,L2

5	To understand concept of containerization and Analyze the Containerization of OS images and deployment of applications over Docker	L1,L2,L3
6	To Synthesize software configuration and provisioning using Ansible.	L1,L2,L3

Prerequisite: Operating System, Linux Administration, Java /Web Application Programming, and Software Engineering.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel i3 core or above 2. 4 GB RAM or above 3. 500 GB HDD 4. Network interface card	1. Linux / Windows Operating system 2. VIRTUAL BOX/ VMWARE	1. Internet Connection for installing additional packages 2. GitHub account 3. Docker hub account

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Knowledge of Linux Operating system, installation and configuration of services and command line basics, Basics of Computer Networks and Software Development Life cycle.	**00**	LO1
I	Introduction to Devops	Understanding of the process to be followed during the development of an application, from the inception of an idea to its final deployment. Learn about the concept of DevOps and the practices and principles followed to implement it in any company's software development life cycle. Learn about the phases of Software Lifecycle. Get familiar with the concept of Minimum Viable Product (MVP) & Cross-functional Teams. Understand why DevOps evolved as a prominent culture in most of the modern-day startups to achieve agility in the software development process **Self-Learning Topics: Scrum, Kanban, Agile**	**04**	LO1
II	Version Control	In this module you will learn: • GIT Installation, Version Control, Working with remote repository • GIT Cheat sheet • Create and fork repositories in GitHub • Apply branching, merging and rebasing concepts. • Implement different Git workflow strategies in real-time scenarios • Understand Git operations in IDE **Self-Learning Topics: AWS Codecommit, Mercurial, Subversion, Bitbucket, CVS**	**04**	LO1 & LO2
III	Continuous Integration using Jenkins	In this module, you will know how to perform Continuous Integration using Jenkins by building and automating test cases using Maven / Gradle / Ant. • Introduction to Jenkins (With Architecture) • Introduction to Maven / Gradle / Ant.	**04**	LO1 & LO3

		• Jenkins Management Adding a slave node to Jenkins • Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to deploy an application over the tomcat server **Self-Learning Topics: Travis CI, Bamboo, GitLab, AWS CodePipeline**		
IV	Continuous Testing with Selenium	In this module, you will learn about selenium and how to automate your test cases for testing web elements. You will also get introduced to X-Path, TestNG and integrate Selenium with Jenkins and Maven. • Introduction to Selenium • Installing Selenium • Creating Test Cases in Selenium WebDriver • Run Selenium Tests in Jenkins Using Maven **Self-Learning Topics: Junit, Cucumber**	**04**	LO1 , LO3 & LO4
V	Continuous Deployment: Containerization with Docker	In this module, you will be introduced to the core concepts and technology behind Docker. Learn in detail about container and various operations performed on it. • Introduction to Docker Architecture and Container Life Cycle • Understanding images and containers • Create and Implement docker images using Dockerfile. • Container Lifecycle and working with containers. • To Build, deploy and manage web or software application on Docker Engine. • Publishing image on Docker Hub. **Self-Learning Topics: Docker Compose, Docker Swarm.**	**05**	LO1 & LO5
VI	Continuous Deployment: Configuration Management with Puppet	In this module, you will learn to Build and operate a scalable automation system. • Puppet Architecture • Puppet Master Slave Communication • Puppet Blocks • Installation and Configuring Puppet Master and Agent on Linux machines • Use exported resources and forge modules to set up Puppet modules • Create efficient manifests to streamline your deployments **Self-Learning Topics: Ansible, Saltstack**	**05**	LO1 & LO6

Text books

1. DevOps Bootcamp, Sybgen Learning
2. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
3. Len Bass,Ingo Weber,Liming Zhu,"DevOps, A Software Architects Perspective", AddisonWesley-Pearson Publication.
4. John Ferguson Smart," Jenkins, The Definitive Guide", O'Reilly Publication.
5. Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet, by Ryan Russell-

Yates Packt Publishing (September 29, 2018)

References:

1. Sanjeev Sharma and Bernie Coyne,” DevOps for Dummies”, Wiley Publication
2. Httermann, Michael, “DevOps for Developers”, Apress Publication.
3. Joakim Verona, “Practical DevOps”, Pack publication
4. Puppet 5 Essentials - Third Edition: A fast-paced guide to automating your infrastructure by Martin Alfke Packt Publishing; 3rd Revised edition (September 13, 2017)

List of Experiments:

Sr.No	**Experiment Title**
1.	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.
2.	To understand Version Control System / Source Code Management, install git and create a GitHub account.
3.	To Perform various GIT operations on local and Remote repositories using GIT Cheat-Sheet
4.	To understand Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to setup a build Job.
5.	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat server.
6.	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.
7.	To Setup and Run Selenium Tests in Jenkins Using Maven.
8.	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers.
9.	To learn Dockerfile instructions, build an image for a sample web application using Dockerfile.
10.	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet.
11.	To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function)
12	To provision a LAMP/MEAN Stack using Puppet Manifest.

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments, one of which must include a Case study on DevOps Implementation in real world and the other one can be based on the self-learning topics mentioned in syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

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Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITL504	Advance DevOps Lab	--	02	--	01	01

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITL504	Advance DevOps Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand DevOps practices and cloud native environments to achieve continuous software delivery pipelines and automated operations that address the gap between IT resources and growing cloud complexity.
2	To Use Kubernetes services to structure N-tier applications.
3	To be familiarized with Infrastructure as code for provisioning, compliance, and management of any cloud infrastructure, and service.
4	To understand that security and speed in software development are not inversely-related objectives Internalizing the contribution of tools and automation in DevSecOps
5	To understand various troubleshooting techniques by monitoring your entire infrastructure and business processes
6	To understand how software and software-defined hardware are provisioned dynamically.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	To understand the fundamentals of Cloud Computing and be fully proficient with Cloud based DevOps solution deployment options to meet your business requirements	L1,L2
2	To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes	L1,L2,L3
3	To apply best practices for managing infrastructure as code environments and use terraform to define and deploy cloud	L1,L2,L3

	infrastructure.	
4	To identify and remediate application vulnerabilities earlier and help integrate security in the development process using SAST Techniques.	L1,L2,L3
5	To use Continuous Monitoring Tools to resolve any system errors (low memory, unreachable server etc.) before they have any negative impact on the business productivity	L1,L2,L3
6	To engineer a composition of nano services using AWS Lambda and Step Functions with the Serverless Framework	L1,L2,L3

Prerequisite: Operating System, Linux Administration, Java /Web Application Programming, Software Engineering, Cloud Computing and DevOps Ecosystem.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel i3 core or above 2. 4 GB RAM or above 3. 500 GB HDD 4. Network interface card	1. Linux / Windows Operating system 2. VIRTUAL BOX/ VMWARE	1. Internet Connection for installing additional packages 2. GitHub account 3. AWS free tier account

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Knowledge of Linux Operating system, installation and configuration of services and command line basics, Basics of Computer Networks, Software Development Life cycle, Cloud Computing and DevOps Ecosystem.	**02**	--
I	Introduction to Devops on Cloud	Learn about various cloud services and service providers, also get the brief idea of how to implement DevOps over Cloud Platforms. • Introduction to high availability architecture and auto-scaling • Set up the DevOps infrastructure on the cloud • Work and set up IDE on Cloud9 • Deploy projects on AWS using Code Build, CodeDeploy, and CodePipeline **Self-Learning Topics:** AWS Codestar	**04**	LO1
II	Container Orchestration using Kubernetes	In this module, you will learn how Kubernetes automates many of the manual processes involved in deploying, managing, and scaling containerized applications. Install and configure Kubernetes Spin Up a Kubernetes Cluster Check the Nodes of Your Kubernetes Cluster	**04**	LO1, LO2

		Installing kubectl to manage cluster and deploy Your First Kubernetes Application **Self-Learning Topics:** • Using Services and Ingresses to Expose Deployments • Perform logging, monitoring, services, and volumes in Kubernetes.		
III	Infrastructure Automation with Terraform	In this module you will learn, Infrastructure as code for provisioning, compliance, and management of any cloud infrastructure, and service. • Introduction to Infrastructure as Code with Terraform • Install, Build, change and Destroy Infrastructure using Terraform. **Self-Learning Topics:** Terraform • Create Resource Dependencies • Provision Infrastructure • Define Input Variables, Query Data with output and store remote state	**04**	LO1, LO3
IV	DevSecOps: Static Application Security Testing (SAST)	In this module, you will learn to identify and remediate application vulnerabilities earlier and help integrate security in the development process using tools like SonarQube / Gitlab / • Perform static analysis on application source code and binaries. • Spot potential vulnerabilities before deployment • Analysis of java / web-based project • Jenkins SonarQube / Gitlab Integration **Self-Learning Topics:** Snyk, OWASP ZAP, Analysis Core Plugin	**04**	LO1, LO4
V	DevSecOps: Continuous Monitoring	In this module, you will learn to detect, report, respond to the attacks and issues which occur within the infrastructure. • Introduction to Continuous Monitoring • Introduction to Nagios • Installing Nagios • Nagios Plugins (NRPE) and Objects Nagios Commands and Notification • Monitoring of different servers using Nagios	**04**	LO1, LO5

		Self-Learning Topics: Splunk, Snort, Tenable		
VI	NoOps: Serverless Computing	In this module, you will learn serverless computing platform like AWS Lambda, which allows you to build your code and deploy it without ever needing to configure or manage underlying servers. • AWS Lambda - Overview and Environment Setup • Building and Configuring the Lambda function (NODEJS/PYTHON/JAVA) • Creating & Deploying using AWS Console/CLI • Creating & Deploying using Serverless Framework **Self-Learning Topics:** AWS Lambda • Create a REST API with the Serverless Framework	**04**	LO1, LO6

Textbooks:

1. AWS Certified SysOps Administrator Official Study Guide: Associate Exam by Stephen Cole (Author), Gareth Digby (Author), Chris Fitch (Author), Steve Friedberg (Author), Shaun Qual
2. AWS Certified Solutions Architect Official Study Guide: Associate Exam by Joe Baron
3. Terraform: Up & Running - Writing Infrastructure as Code, Second Edition by Yevgeniy Brikman , O'Reilly
4. Kubernetes: Up and Running - Dive into the Future of Infrastructure, Second Editionby Brendan Burns,O'Reilly
5. Going Serverless with AWS Lambda: Leveraging the latest services from the AWS cloud by Ajay Pherwani , Shroff/X-Team;
6. Learning Nagios, Packt Publishing.

References:

1. Learning Aws - Second Edition: Design, build, and deploy responsive applications using AWS by Amit Shah Aurobindo Sarkar
2. Mastering Aws Lambda by Yohan Wadia Udita Gupta

List of Experiments:

Sr. No	Experiment Title
1	To understand the benefits of Cloud Infrastructure and Setup AWS Cloud9 IDE, Launch AWS Cloud9 IDE and Perform Collaboration Demonstration.
2	To Build Your Application using AWS CodeBuild and Deploy on S3 / SEBS using AWS CodePipeline, deploy Sample Application on EC2 instance using AWS CodeDeploy.
3	To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.
4	To install Kubectl and execute Kubectl commands to manage the Kubernetes cluster and deploy Your First Kubernetes Application.

5	To understand terraform lifecycle, core concepts/terminologies and install it on a Linux Machine.
6	To Build, change, and destroy AWS / GCP /Microsoft Azure/ DigitalOcean infrastructure Using Terraform.
7	To understand Static Analysis SAST process and learn to integrate Jenkins SAST to SonarQube/GitLab.
8	Create a Jenkins CICD Pipeline with SonarQube / GitLab Integration to perform a static analysis of the code to detect bugs, code smells, and security vulnerabilities on a sample Web / Java / Python application.
9	To Understand Continuous monitoring and Installation and configuration of Nagios Core, Nagios Plugins and NRPE (Nagios Remote Plugin Executor) on Linux Machine.
10	To perform Port, Service monitoring, Windows/Linux server monitoring using Nagios.
11	To understand AWS Lambda, its workflow, various functions and create your first Lambda functions using Python / Java / Nodejs.
12	To create a Lambda function which will log “An Image has been added” once you add an object to a specific bucket in S3.

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the self-learning topics mentioned in syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	**Course Name**	**Teaching scheme**			**Credit assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITL505	Professional Communication & Ethics-II (PCE-II)	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ITL505	Professional Communication & Ethics-II (PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	**Course Name**	**Credits**
ITL505	Professional Communication & Ethics-II (PCE-II)	02
Course Rationale	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	• To discern and develop an effective style of writing important technical/business documents. • To investigate possible resources and plan a successful job campaign. • To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. • To develop creative and impactful presentation skills. • To analyze personal traits, interests, values, aptitudes and skills. • To understand the importance of integrity and develop a personal code of ethics.	
Course Outcomes	**Learner will be able to…** • plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. • strategize their personal and professional skills to build a professional image and meet the demands of the industry. • emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. • deliver persuasive and professional presentations. • develop creative thinking and interpersonal skills required for effective professional communication. • apply codes of ethical conduct, personal integrity and norms of organizational behaviour.	

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)** **1.1 Purpose and Classification of Reports:** **Classification on the basis of:** • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long) **1.2. Parts of a Long Formal Report:** • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter) **1.3. Language and Style of Reports** • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers **1.4. Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) **1.5. Parts of a Proposal** • Elements • Scope and Limitations • Conclusion **1.6. Technical Paper Writing** • Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) • Language and Formatting • Referencing in IEEE Format	**06**
2	**EMPLOYMENT SKILLS** **2.1. Cover Letter & Resume** • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination) **2.2 Statement of Purpose** • Importance of SOP • Tips for Writing an Effective SOP **2.3 Verbal Aptitude Test** • Modelled on CAT, GRE, GMAT exams **2.4. Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays)	**06**

	• GD Etiquettes **2.5. Personal Interviews** • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3	**BUSINESS MEETINGS** **1.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	**02**
4	**TECHNICAL/ BUSINESS PRESENTATIONS** **1.1 Effective Presentation Strategies** • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills **1.2 Group Presentations** • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	**02**
5	**INTERPERSONAL SKILLS** **1.1. Interpersonal Skills** • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making **5.2 Start-up Skills** • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	**08**
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** • Copyrights • Trademarks • Patents • Industrial Designs	**02**

	• Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) **6.2 Case Studies** • Cases related to Business/ Corporate Ethics	

List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.
The distribution of marks for term work shall be as follows:
Assignment : 10 Marks
Attendance : 5 Marks
Presentation slides : 5 Marks
Book Report (hard copy) : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion : 10 marks
Project Presentation : 10 Marks
Group Dynamics : 5 Marks

Books Recommended:

Textbooks and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England:

Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press

Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM501	Mini Project – 2 A Web Based Business Model	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM501	Mini Project – 2 A Web Based Business Model	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5011	Microcontroller Embedded Programming	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITDO5011	Microcontroller Embedded Programming	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Conceptualize the architecture of embedded systems.
2	Study the basics of microcontroller 8051.
3	Elaborate on the concepts of microcontroller interfacing.
4	Understand the concepts of ARM architecture
5	Study the concepts of real-time operating system
6	Learn about various embedded platforms and their programming

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Introduce and discuss the embedded system concepts, architecture of embedded systems and understand the embedded development environments	L1, L2
2	Describe the architecture of 8051 microcontroller and write embedded programs for 8051Microcontroller	L2, L3
3	Illustrate the interfacing of peripherals with 8051 microcontroller and write programs	L2, L3
4	Understand and apply the concepts of ARM architecture	L2, L3
5	Explain and Demonstrate the open source RTOS	L3
6	**Select** the embedded platform and program it for real time application	L3, L4

Prerequisite: Computer Organization and Architecture, Operating System.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Revision of microcomputer system terminologies, High level, difference between microprocessor and microcontroller, basics of operating System.	**02**	--
I	Introduction to Embedded systems	Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC. Introduction to Embedded System Integrated Development Environments (IDEs) with examples. **Self-learning Topics:** Comparison of CISC & RISC, Case studies of Real Time Embedded Systems.	**04**	CO1
II	The Microcontroller Architecture and Programming of 8051	Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory Organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. Addressing modes, Instruction set 8051 developing tools, Programming based on Arithmetic & Logical Operations, I/O parallel and serial ports, Timers & Counters, and ISR. **Self-learning Topics:** Writing 8051 programming in Embedded C	**10**	CO2
III	Interfacing with 8051Microcontroller	Interfacing 8051 with peripherals: ADC, DAC, stepper motor. Interfacing 8051 with LED, LCD, keyboard, Temp sensor, etc. using assembly language. **Self-learning Topics:** Study of 8051 based GSM, Bluetooth and RS232 communication	**04**	CO3
IV	ARM 7 Architecture	Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Addressing modes, Instruction set: Data processing, Data Transfer, Control flow. Pipelining, Writing simple assembly language programs.	**07**	CO4

		Brief introduction to exceptions and interrupts handling. **Self-learning Topics:** Writing ARM programs in Embedded C and Python for sensor application		
V	Open source RTOS Real Time system concept with embedded OS	Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, Basic architecture of an RTOS, scheduling systems, Inter-process-communication using pipes and mailboxes, performance matrix in scheduling models, interrupt management in RTOS environment, RTOS comparative study. ucos2 for real time embedded system demonstrate one case study: Case study of automobile RTOS issues in multitasking –selecting a Real Time Operating System **Self-learning Topics:** Inter-process-communication using semaphore, and Mutex, RTOS simple programming using ucos2	**07**	CO5
VI	Introduction to Embedded Platforms	Overview of various Embedded hardware Platforms: Architecture of Arduino, Basic Arduino programming using Arduino IDE and Arduino libraries for interfacing of LCD and sensors such as Temperature (DHT11), Pressure, Humidity. RaspberryPi (RPi-Functional Block diagram and its operation, GPIO pins, Features of RaspbianOS) Programming Arduino using python (pyserial or pyfirmata): blink.py Programming RaspberryPi GPIO using python: blink.py **Self-learning Topics:** Study of Arduino/ RaspberryPi using Thingspeak cloud platform and Blink app using Mobile.	**05**	CO6

Textbooks:

1 M. A. Mazidi, J. G. Mazidi, R. D., McKinlay,” The 8051 microcontroller & Embedded systems Using Assembly and C”, Pearson, 3rd edition
2 Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech press, Reprint edition 2013
3 Shibu K. V., “Introduction to embedded systems”, McGraw Hill

References:

1 Steve Furber, “ARM System on chip Architecture”, Pearson, edition second
2 Laya B. Das, “Embedded systems an integrated approach”, Pearson, Third impression, 2013
3 Embedded Systems, Architecture, program and Design by Rajkamal
4 Simon Monk,” Raspberry Pi Cookbook”, O’reilly
5 Massimo Banzi, “Getting Started with Arduino: The Open Source Electronics Prototyping Platform (Make)”, O'Reilly Media.
6 https://nptel.ac.in/courses/117/104/117104072/
7 https://www.coursera.org/learn/raspberry-pi-platform

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITDO5012	Advance Data Management Technologies	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITDO5012	Advance Data Management Technologies	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To impart knowledge related to query processing and query optimization phases of a database management system.
2	To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.
3	To introduce advanced database models like distributed databases.
4	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.
5	To understand the process of data extraction, transformation and loading.
6	To understand the concept of Big data and NoSQL databases..

Course Outcomes:

Sr. No.	Course Outcomes:	Cognitive levels of attainment as per bloom's Taxonomy
1	Measure query costs and design alternate efficient paths for query execution**.**	L1,L2
2	Apply sophisticated access protocols to control access to the database.	L1,L2,L3
3	Implement Distributed databases.	L1,L2,L3

4	Organize strategic data in an enterprise and build a data Warehouse.	L1,L2,L3
5	Analyse data using OLAP operations so as to take strategic decisions.	L1,L2,L3,L4
6	Design modern applications using NoSQL databases**.** databases**.**	L1,L2,L3,L4

Prerequisite: Course on Database Management System

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Reviewing basic concepts of a Relational database, SQL concepts	**02**	----
I	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression, Estimating Statistics of Expression Results Choice of Evaluation Plans. **Self-learning Topics:** Solve problems on query optimization.	**06**	CO1
II	Advanced Data Management Techniques	**Advanced Database Access protocols:** Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role-Based Access Control, Remote Database access protocol. Overview of Advanced Database Models like Mobile databases, Temporal databases, Spatial databases. **Self-learning Topics**: Learn Data Security concepts like Authentication, Authorization and encryption.	**06**	CO2
III	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. **Self-learning Topics**: Query Optimization in Distributed Databases	**04**	CO3
IV	Data Warehousing, Dimensional Modelling and OLAP	The Need for Data Warehousing; Data Warehouse Defined; Is data warehouse still relevant in the age of big data, Features of a Data Warehouse; Data Warehouse Architecture-Enterprise or centralized, federated and multi tired architectures; Data Warehouse and Data Marts; Data Warehousing Design Strategies, Data modeling-Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table;, Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys. What is business intelligence, use of BI, Tools used in BI, Need for Online Analytical Processing; OLAP Operations	**09**	CO4

		in a cube: Roll-up, Drill-down, Slice, Dice, Pivot; OLAP Architectures: MOLAP, ROLAP, DOLAP and HOLAP. **Self-learning Topics:** Explore life cycle of data warehouse development		
V	ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading **Self-learning Topics:** Find out various ETL tools for enterprise data management.	**05**	CO5
VI	Big data and NoSQL	Big data and NoSQL : Introduction, types and characteristics of big data, What is NoSQL, CAP theorem, BASE property, NoSQL data architecture patterns: Key-value stores, Graph stores, Column family stores, Document stores. **Self-learning Topics:** Google's Bigtable, Cassandra, MongoDB, Neo4j	**07**	CO6

Textbooks:

1 Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2 Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3 Theraja Reema, "Data Warehousing", Oxford University Press.
4 Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill

References:

1 Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2 Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling", 3rd Edition. Wiley India.
3 Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
4 Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 9th Edition.

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5013	Computer Graphics & Multimedia System	03	--	03	--	03

Course Code	Course Name	Examination Scheme								
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITDO5013	Computer Graphics & Multimedia System	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To equip student with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasize on understanding of Computer Graphics Algorithms.
3	To prepare the student for advanced areas in the field of Computer Graphics.
4	To introduce student for professional avenues in the field of Computer Graphics
5	To introduce students about basic fundamentals and key aspects of Multimedia system.
6	To equip the students for various techniques of Multimedia.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concepts of Computer Graphics.	L1,L2
2	Demonstrate various algorithms for basic graphics primitives.	L1,L2
3	Apply 2-D geometric transformations on graphical objects. Use various Clipping algorithms on graphical objects	L1,L2,L3
4	Explore 3-D geometric transformations and curve representation techniques.	L1,L2,L3
5	Describe the basics of Multimedia System	L1,L2
6	Explore the Digital images audio & video and their related concepts.	L1,L2,L3

Prerequisite: Basic knowledge of mathematics.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	**Basic** knowledge of mathematics	--	---
I	Introduction	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, Raster scan & random scan displays, Architecture of raster graphicssystem with display processor, Architecture of random scan systems. **Self-learning Topics:-** study the working of some Raster scan display devices	**02**	CO1
II	Output Primitives	Scan conversions of point, line and circle: DDA algorithm and Brenham algorithm for line drawing, Midpoint algorithm for circle, Aliasing, Antialiasing techniques like Pre filtering and post filtering, super sampling, and pixel phasing. Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm. **Self-learning Topics:-**Implementation of DDA and Bresenhams line algorithm for dotted line, dashed line, Dash-dot line etc.	**08**	CO2
III	Two Dimensional Transformations and Clipping	Basic 2D transformations:- Translation, Scaling, Rotation, Reflection. Matrix representation and Homogeneous Coordinates. Composite transformation. Viewing transformation pipeline and Window to Viewport coordinate transformation. Clipping operations: Point clipping, Line Clipping. Line clipping algorithms: Cohen- Sutherland, Liang-Barsky, Polygon Clipping Algorithms: Sutherland- Hodgeman, Weiler-Atherton. **Self-learning Topics:-**Implementation of 2D transformations like translation, rotation and scaling. Implementation of clipping algorithm.	**09**	CO3
IV	3D Transformation, curves and fractals	3D Transformations: Translation, Rotation, Scaling. Reflection , Composite transformations: Rotation about an arbitrary axis. Bezier Curve, B-Spline Curve.	**06**	CO4

		Fractal-Geometry: Fractal Dimension, Hilbert's curve, Koch Curve. **Self-learning Topics:-**Implementation of 3D transformations, Bezier curve , Koch curve.		
V	**Introduction to Multimedia**	Overview, Objects and Elements of Multimedia, Applications of Multimedia, Multimedia Systems Architecture – IMA, Workstation, Network, Types of Medium (Perception, Representation-..), Interaction Techniques **Self-learning Topics:-**Study the objects and elements of multimedia	**04**	CO5
VI	Digital Image, audio & video	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), File formats: JPG. Compression Techniques: fundamentals (coding, inter pixel and psychovisual redundancies). Types – lossless and lossy Compression, Lossless Compression Algorithms– Shannon-Fano, Lossy Compression Algorithm – JPEG **Digital Audio** Basic Sound Concepts: computer representation of sound File Formats – WAV **Digital Video** Digitization of Video, types of video signals (component, composite and S- video). File Formats: MPEG Video **Self-learning Topics:-**Implementation of compression algorithms, Analysis of Digital audio and digital video file formats.	**10**	CO6

Text Books:

1 Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication
2 James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2ndEdition, Pearson Publication
3 Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.
4 Multimedia System Design, Prabhat K. Andleigh& Kiran Thakrar, PHI
5 Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

References:

1 D. Rogers, “Procedural Elements for Computer Graphics”, Tata McGraw-Hill Publications.
2 Samit Bhattacharya, “Computer Graphics”, Oxford Publication
3 Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic & Dragorad A. Milovanovic, TMH.
4 Multimedia Systems, K. Buford, PHI.

Sr.No	Online Resources
1	https://nptel.ac.in/courses/106/106/106106090/
2	https://nptel.ac.in/courses/106/103/106103224/
3	https://nptel.ac.in/courses/106/102/106102065/
4	https://onlinecourses.swayam2.ac.in/nou21_cs04/preview
5	https://nptel.ac.in/courses/117/105/117105083/

Assessment:

Internal Assessment (IA)for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITDO5014	Advanced Data structure and Analysis	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITDO5014	Advanced Data structure and Analysis	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn mathematical background for analysis of algorithm
2	To learn various advanced data structures.
3	To understand the different design approaches of algorithm.
4	To learn dynamic programming methods.
5	To understand the concept of pattern matching
6	To learn advanced algorithms.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the different methods for analysis of algorithms.	L1,L2
2	Choose an appropriate advanced data structure to solve a specific problem.	L1,L2
3	Apply an appropriate algorithmic design approach for a given problem.	L1,L2,L3
4	Apply the dynamic programming technique to solve a given problem.	L1,L2,L3
5	Select an appropriate pattern matching algorithm for a given application.	L1,L2,L3
6	Understand the concepts of Optimization, Approximation and Parallel computing algorithms.	L1,L2

Prerequisite: Data structures and Analysis, Knowledge of Any Programming Language

DETAILED SYLLABUS:

Sr. No	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of Data structures and analysis and programming language.	**02**	-
I	Introduction	Fundamentals of the analysis of algorithms: Time and Space complexity, Asymptotic analysis and notation, average and worst-case analysis, Recurrences: The substitution method, Recursive tree method, Masters method. **Self-learning Topics:** Analysis of Time and space complexity of iterative and recursive algorithms	**04**	CO1
II	Advanced Data Structures	B/B+ tree, Red-Black Trees, Heap operations, Implementation of priority queue using heap, Topological Sort. **Self-learning Topics:** Implementation of Red-Black Tree and Heaps.	**05**	CO2
III	Divide and Conquer AND Greedy algorithms	Introduction to Divide and conquer, Analysis of Binary Search, Merge sort and Quick sort, Finding minimum and maximum algorithm. Introduction to Greedy Algorithms: Knapsack Problem, Job sequencing using deadlines, Optimal storage on tape, Optimal Merge Pattern, Analysis of all these algorithms and problem solving. **Self-learning Topics:** Implementation of minimum and maximum algorithm, Knapsack problem, Job sequencing using deadlines.	**08**	CO3
IV	Dynamic algorithms	Introduction to Dynamic Algorithms, all pair shortest path, 0/1 knapsack, travelling salesman problem, Matrix Chain Multiplication, Optimal binary search tree, Analysis of All algorithms and problem solving. **Self-learning Topics:** Implementation of All pair shortest path, 0/1 Knapsack and OBST.	**06**	CO4
V	String Matching	Introduction, the naïve string matching algorithm, Rabin Karp algorithm, Boyer Moore algorithm, Knuth-Morris-Pratt algorithm, Longest Common Subsequence (LCS), Analysis of All algorithms and problem solving. **Self-learning Topics:** Implementation of Robin Karp algorithm, KMP algorithm and LCS.	**07**	CO5

VI	Advanced Algorithms and NP problems	**Optimization Algorithms:** Genetic algorithm(GA), **Approximation Algorithms:** Vertex-cover problem, **Parallel Computing Algorithms:** Fast Fourier Transform, **Introduction to NP-Hard and NP-Complete Problems** **Self-learning Topics:** Implementation of Genetic algorithm and Vertex-cover problem	**07**	CO6

Textbooks:

1 Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, PHI.
2 Algorithms: Design and Analysis, Harsh Bhasin, OXFORD.
3 Fundamentals of Computer Algorithms, Horowitz, Sahani, Rajsekaran, Universities Press.
4 C and Data structures, Deshpande, Kakde, Dreamtech Press.

References:

1 Data Structures and Algorithms in C++, Goodritch, Tamassia, Mount, WILEY.
2 Data Structures using C, Reema Thareja , OXFORD.
3 Data Structures and Algorithm Analysis in C, Mark A. Weiss, Pearson.
4 Optimization Algorithms and Applications, By Rajesh Kumar Arora by Chapman and Hall

Online Resources

Sr.No	Website Links
1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

Program Structure for Third Year Information Technology
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester VI

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Pract. Tut.**	**Theory**	**Pract.**	**Total**
ITC601	Data Mining & Business Intelligence	3	--	3	--	3
ITC602	Web X.0	3	--	3		3
ITC603	Wireless Technology	3	--	3	--	3
ITC604	AI and DS – 1	3	--	3	--	3
ITDO601 X	**Department Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL601	BI Lab	--	2	--	1	1
ITL602	Web Lab	--	2	--	1	1
ITL603	Sensor Lab	--	2	--	1	1
ITL604	MAD & PWA Lab	--	2	--	1	1
ITL605	DS using Python Skill based Lab	--	2	--	1	1
ITM601	Mini Project – 2 B Based on ML	--	$4^{\$}$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100
ITC602	Web X.0	20	20	20	80	3	--	--	100
ITC603	Wireless Technology	20	20	20	80	3	--	--	100
ITC604	AI and DS – 1	20	20	20	80	3	--	--	100
ITDO601 X	**Department Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL601	BI Lab	--	--	--	--	--	25	25	50
ITL602	Web Lab	--	--	--	--	--	25	25	50
ITL603	Sensor Lab	--	--	--	--	--	25	25	50
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50

ITL605	DS using Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM601	Mini Project – 2 B Based on ML	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO601X	**Department Optional Course – 2**
ITDO6011	Software Architecture
ITDO6012	Image Processing
ITDO6013	Green IT
ITDO6014	Ethical Hacking and Forensic

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC601	Data Mining & Business Intelligence	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce the concept of data warehouse data Mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage.
2	To enable students to effectively identify sources of data and process it for data mining.
3	To make students well versed in all data mining algorithms, methods of evaluation.
4	To impart knowledge of tools used for data mining
5	To provide knowledge on how to gather and analyze large sets of data to gain useful business understanding.
6	To impart skills that can enable students to approach business problems analytically identifying opportunities to derive business value from data.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate an understanding of the importance of data warehousing and data mining and the principles of business intelligence.	L1
2	Organize and prepare the data needed for data mining using pre preprocessing techniques.	L1,L2,L3
3	Perform exploratory analysis of the data to be used for mining.	L1,L2,L3,L4
4	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.	L1,L2,L3,L4,L5
5	Define and apply metrics to measure the performance of various data mining	L1,L2,L3

	algorithms.	
6	Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.	L1,L2,L3

Prerequisite: Database Management System

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Knowledge of databases	**01**	**-**
I	Data Warehouse (DWH) Fundamentals with Introduction to Data Mining	DWH characteristics, Dimensional modeling: Star, Snowflakes, OLAP operation, OLTP vs OLAP Data Mining as a step in KDD, Kind of patterns to be mined, Technologies used, Data Mining applications. **Self-learning Topics:** Data Marts, Major issues in Data Mining.	**04**	CO1
II	Data Exploration and Data Preprocessing	Types of Attributes, Statistical Description of Data, Measuring Data Similarity and Dissimilarity. Why Preprocessing? Data Cleaning, Data Integration, Data Reduction: Attribute Subset Selection, Histograms, Clustering, Sampling, Data Cube aggregation, Data transformation and Data Discretization: Normalization, Binning, Histogram Analysis **Self-learning Topics** Data Visualization, Concept hierarchy generation	**06**	CO2, CO3
III	Classification	Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes Classifier. Prediction: Structure of regression models; Simple linear regression, Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation, Bootstrap, Introduction of Ensemble methods, Bagging, Boosting, AdaBoost and Random forest. **Self-learning Topics:** Multiple linear regression, logistic regression, Random forest, nearest neighbour classifier, SVM	**08**	CO4, CO5
IV	Clustering and Outlier Detection	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K Medoids; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN. What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised,	**08**	CO4

		Unsupervised, Proximity based, Clustering Based. **Self-learning Topics** Hierarchical methods : Chameleon, Density based methods: OPTICS, Grid based methods: STING, CLIQUE		
V	Frequent Pattern Mining	**Basic Concepts**: Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules; Frequent Itemset. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from Frequent Itemset, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical data formats; Introduction to Advance Pattern Mining: Mining Multilevel Association Rules and Multidimensional Association Rules. **Self-learning Topics:** Association Mining to Correlation Analysis, lift, Introduction to Constraint-Based Association Mining	**08**	CO4, CO5
VI	Business Intelligence	What is BI? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Recommendation System **Self-learning Topics:** Clickstream Mining, Market Segmentation, Retail industry, Telecommunications industry, Banking & finance CRM, Epidemic prediction, Fake News Detection, Cyberbullying, Sentiment Analysis etc.	**04**	CO6

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education.
3. Paulraj Ponniah “Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals” Wiley Publications
4. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis, Wiley India Publications.
5. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 2nd Edition, Wiley India.

References:

1. Michael Berry and Gordon Linoff “Data Mining Techniques”, 2nd Edition Wiley Publications.
2. Michael Berry and Gordon Linoff “Mastering Data Mining- Art & science of CRM”, Wiley Student Edition.
3. Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4. Data Mining https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC602	Web X.0	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC602	Web X.0	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the digital evolution of web technology.
2	To learn Type Script and understand how to use it in web application.
3	To empower the use of AngularJS to create web applications that depend on the Model-View-Controller Architecture.
4	To gain expertise in a leading document-oriented NoSQL database, designed for speed, scalability, and developer agility using MongoDB.
5	To build web applications quickly and with less code using Flask framework.
6	To gain knowledge of Rich Internet Application Technologies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to web analytics and semantic web.	L1, L2
2	Understand how TypeScript can help you eliminate bugs in your code and enable you to scale your code.	L1, L2
3	Understand AngularJS framework and build dynamic, responsive single-page web applications.	L2, L3
4	Apply MongoDB for frontend and backend connectivity using REST API.	L1, L2, L3
5	Apply Flask web development framework to build web applications with less code.	L1, L2, L3

6	Develop Rich Internet Application using proper choice of Framework.	L1, L2, L3, L4

Prerequisite: Object Oriented Programming, Python Programming, HTML and CSS.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	HTML/HTML5 (Tags, Attributes and their properties), CSS/CSS3 (Types and Properties), Basics of Java Script, Python Programming	**02**	--
I	Introduction to WebX.0	**Evolution of WebX.0**; **Web Analytics 2.0**: Introduction to Web Analytics, Web Analytics 2.0, Clickstream Analysis, Strategy to choose your web analytics tool, Measuring the success of a website; **Web3.0 and Semantic Web**: Characteristics of Semantic Web, Components of Semantic Web, Semantic Web Stack, N-Triples and Turtle, Ontology, RDF and SPARQL **Self-learning Topics**: Semantic Web Vs AI, SPARQL Vs SQL.	**04**	CO1
II	Type Script	Overview, TypeScript Internal Architecture, TypeScript Environment Setup, TypeScript Types, variables and operators, Decision Making and loops, TypeScript Functions, TypeScript Classes and Objects, TypeScript Modules **Self-learning Topics**: Javascript Vs TypeScript	**06**	CO2
III	Introduction to AngularJS	Overview of AngularJS, Need of AngularJS in real web sites, AngularJS modules, AngularJS built-in directives, AngularJS custom directives, AngularJS expressions, Angular JS Data Binding, AngularJS filters, AngularJS controllers, AngularJS scope, AngularJS dependency injection, Angular JS Services, Form Validation, Routing using ng-Route, ng-Repeat, ng-style, ng-view, Built-in Helper Functions, Using Angular JS with Typescript **Self-learning Topics**: MVC model, DOM model, Javascript functions and Error Handling	**08**	CO3
IV	MongoDB and Building REST API using MongoDB	**MongoDB**: Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control, Adding the MongoDB Driver to Node.js, Connecting to MongoDB from Node.js, Accessing and Manipulating Databases, Manipulating MongoDB Documents from Node.js, Accessing MongoDB from Node.js, Using Mongoose for Structured Schema and Validation. **REST API**: Examining the rules of REST APIs, Evaluating API patterns, Handling typical CRUD functions (create, read, update, delete), Using Express and Mongoose to interact with MongoDB, Testing API endpoints **Self-learning Topics**: MongoDB vs SQL DB	**08**	CO4
V	Flask	Introduction, Flask Environment Setup, App Routing, URL Building, Flask HTTP Methods, Flask Request Object, Flask cookies, File Uploading in Flask	**06**	CO5

		Self-learning Topics: Flask Vs Django		
VI	Rich Internet Application	**AJAX:** Introduction and Working **Developing RIA using AJAX Techniques**: CSS, HTML, DOM, XML HTTP Request, JavaScript, PHP, AJAX as REST Client **Introduction to Open Source Frameworks and CMS for RIA**: Django, Drupal, Joomla **Self-learning Topics**: Applications of AJAX in Blogs, Wikis and RSS Feeds	**05**	CO6

Text Books:

1. Boris Cherny, “Programming TypeScript- Making Your Javascript Application Scale”, O’Reilly Media Inc.
2. Adam Bretz and Colin J. Ihrig, “Full Stack JavaScript Development with MEAN”, SitePoint Pty. Ltd.
3. Simon Holmes Clive Harber, “Getting MEAN with Mongo, Express, Angular, and Node”, Manning Publications.
4. Miguel Grinberg, “Flask Web Development: Developing Web Applications with Python”, O’Reilly.
5. Dr. Deven Shah, “Advanced Internet Programming”, StarEdu Solutions.

References:

1. Yakov Fain and Anton Moiseev, “TypeScript Quickly”, Manning Publications.
2. Steve Fenton, “Pro TypeScript: Application - Scale Javascript Development”, Apress
3. Brad Dayley, Brendan Dayley, Caleb Dayley, “Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications”, 2nd Edition, Addison-Wesley Professional

Online References:

Sr. No.	**Website Links**
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org
4.	https://udemy.com

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC603	Wireless Technology	03	--	--	03	--	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITC603	Wireless Technology	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	Discuss the Fundamentals of Wireless Communication.
2	Comprehend the Fundamental Principles of Wide Area Wireless Networking Technologies and their Applications.
3	Explain Wireless Metropolitan and Local Area Networks.
4	Describe Wireless Personal Area Networks and Ad hoc Networks
5	Learn and Analyze Wireless Network Security Standards.
6	Study the Design Considerations for Wireless Networks.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concepts of Wireless Network and Wireless Generations.	L1,L2
2	Demonstrate and Evaluate the various Wide Area Wireless Technologies.	L1,L2,L3, L4, L5
3	Analyze the prevalent IEEE standards used for implementation of WLAN and WMAN Technologies	L1,L2,L3,L4
4	Appraise the importance of WPAN, WSN and Ad-hoc Networks.	L1,L2,L3,L4,L5
5	Analyze various Wireless Network Security Standards.	L1,L2,L3,L4
6	Review the design considerations for deploying the Wireless Network Infrastructure.	L1,L2

Prerequisite: Principle of Communication, Computer Network and Network Design, Computer Network Security.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Digital Modulation Techniques – ASK, FSK, BPSK, QPSK; Electromagnetic Spectrum; Multiplexing Techniques – FDM, TDM, OFDM; OSI and TCP/IP Model; Need for Security, Types of Security Threats and Attacks.	**02**	--
I	Fundamentals of Wireless Communication	Introduction to Wireless Communication - Advantages, Disadvantages and Applications; Multiple Access Techniques - FDMA, TDMA, CDMA, OFDMA; Spread Spectrum Techniques – DSSS, FHSS; Evolution of wireless generations – 1G to 5G (Based on technological differences and advancements); 5G – Key requirements and drivers of 5G systems, Use cases, Massive MIMO. **Self-learning Topics:** Modulation Techniques - QAM, MSK, GMSK	**07**	CO1
II	Wide Area Wireless Networks	Principle of Cellular Communication – Frequency Reuse concept, cluster size and system capacity, co-channel interference and signal quality; GSM – System Architecture, GSM Radio Subsystem, Frame Structure; GPRS and EDGE – System Architecture; UMTS – Network Architecture; CDMA 2000 – Network Architecture; LTE – Network Architecture; Overview of LoRa & LoRaWAN. **Self-learning Topics:-** IS-95	**09**	CO2
III	Wireless Metropolitan and Local Area Networks	IEEE 802.16 (WiMax) – Mesh mode, Physical and MAC layer; IEEE 802.11(Wi-Fi) – Architecture, Protocol Stack, Enhancements and Applications. **Self-learning Topics:-** WLL(Wireless Local Loop).	**06**	CO3
IV	Wireless Personal Area Networks and Ad hoc Networks	IEEE 802.15.1 (Bluetooth) – Piconet, Scatter net, Protocol Stack; IEEE 802.15.4 (ZigBee) – LR-WPAN Device Architecture, Protocol Stack; Wireless Sensor Network – Design Considerations, Issues and Challenges, WSN Architecture, Applications; Introduction of Ad hoc Networks – MANET and VANET – Characteristics, Applications, Advantages and Limitations; Over view of E-VANET(Electrical Vehicular AdHoc Networks). **Self-learning Topics**:- HR–WPAN (UWB)	**08**	CO4
V	Wireless Network Security	Security in GSM; UMTS Security; Bluetooth Security; WEP; WPA2. **Self-learning Topics :-** Study of Wireless Security Tools.	**04**	CO5

VI	Wireless Network Design Considerations	Cisco Unified Wireless Network; Designing Wireless Networks with Lightweight Access Points and Wireless LAN Controllers. **Self-learning Topics:-** Cisco Unified Wireless Network Mobility Services.	**03**	CO6

Text Books:

1. Wireless Communications, T.L. Singal, McGraw Hill Education.
2. Wireless Communications and Networking, Vijay Garg, Morgan Kaufmann Publishers.
3. Wireless Mobile Internet Security, 2nd Edition, Man Young Rhee, A John Wiley & Sons, Ltd., Publication.
4. 5G Outlook–Innovations and Applications,Ramjee Prasad,River Publishers Series in Communications.
5. Designing for Cisco Internetwork Solutions, 2nd Edition, CCDA, Diane Teare, Cisco Press.

Reference Books:

1. Cellular Communications: A Comprehensive and Practical Guide, Nishith Tripathi, Jeffery H Reed, Wiley.
2. Wireless Communications- Principles & Practice,Theodore S. Rappaport, Prentice Hall Series.
3. Wireless Communications and Networks", William Stallings, Pearson / Prentice Hall.
4. Adhoc & Sensor Networks Theory and Applications, Carlos de Morais Cordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.
5. Wireless Networks, Nicopolitidia, M S Obaidat, GI Papadimitriou, Wiley India (Student Edition, 2010).

Online References:

Sr. No.	Website/Reference link
1.	www.swayam.gov.in
2.	www.coursera.org
3.	https://doi.org/10.1007/978-3-642-17878-8_63
4.	https://doi.org/10.1007/978-3-642-54525-2_44
5.	https://lora-alliance.org/resource_hub/what-is-lorawan/
6.	https://doi.org/10.1007/s42835-021-00687-8

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC604	AI and DS - 1	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC604	AI and DS - 1	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce the students' with different issues involved in trying to define and simulate intelligence.
2	To familiarize the students' with specific, well known Artificial Intelligence methods, algorithms and knowledge representation schemes.
3	To introduce students' different techniques which will help them build simple intelligent systems based on AI/IA concepts.
4	To introduce students to data science and problem solving with data science and statistics.
5	To enable students to choose appropriately from a wider range of exploratory and inferential methods for analyzing data, and interpret the results contextually.
6	To enable students to apply types of machine learning methods for real world problems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents.	L1
2	Apply an appropriate problem-solving method and knowledge-representation scheme.	L1,L2,L3
3	Develop an ability to analyze and formalize the problem (as a state space, graph, etc.). They will be able to evaluate and select the appropriate search method.	L1,L2,L3,L4
4	Apply problem solving concepts with data science and will be able to tackle them from a statistical perspective.	L1,L2,L3

5	Choose and apply appropriately from a wider range of exploratory and inferential methods for analyzing data and will be able to evaluate and interpret the results contextually.	L1,L2,L3
6	Understand and apply types of machine learning methods for real world problems.	L1,L2, L3

Prerequisite:

1. Engineering Mathematics III (ITC301)
2. Data Structures and Analysis (ITC302)
3. Engineering Mathematics IV (ITC401)

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Nil**	**--**	--
I	Introduction to AI	**Introduction:** Introduction to AI, AI techniques, Problem Formulation. **Intelligent Agents:** Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent. **Self-Learning Topics :** Identify application areas of AI	**04**	CO1
II	Search Techniques	Uninformed Search Techniques: Uniform cost search, Depth Limited Search, Iterative Deepening, Bidirectional search. Informed Search Methods: Heuristic functions, Best First Search, A*, Hill Climbing, Simulated Annealing. Constraint Satisfaction Problem Solving: Crypto-Arithmetic Problem, Water Jug, Graph Coloring. Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning. Comparing Different Techniques. **Self-Learning Topics :** IDA*, SMA*	**09**	CO2
III	Knowledge Representation using First Order Logic	**Knowledge and Reasoning:** A Knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic, First Order Predicate Logic, Forward and Backward Chaining, Resolution. Planning as an application of a knowledge based agent. Concepts of Partial Order planning, Hierarchical Planning and Conditional Planning. **Self-Learning Topics:** Representing real world problems as planning problems.	**06**	CO3
IV	Introduction to DS	Introduction and Evolution of Data Science, Data Science Vs. Business Analytics Vs. Big Data, Data Analytics, Lifecycle, Roles in Data Science Projects. **Self-Learning Topics :** Applications and Case Studies of Data Science in various Industries	**04**	CO4
V	Exploratory Data Analysis	Introduction to exploratory data analysis, Typical data formats. Types of EDA, Graphical/Non graphical Methods, Univariate/multivariate methods Correlation and covariance, Degree of freedom	**08**	CO5

		Statistical Methods for Evaluation including ANOVA. **Self-Learning Topics:** Implementation of graphical EDA methods.		
VI	Introduction to ML	Introduction to Machine Learning, Types of Machine Learning: Supervised **(**Logistic Regression, Decision Tree, Support Vector Machine) and Unsupervised (K Means Clustering, Hierarchical Clustering, Association Rules) Issues in Machine learning, Application of Machine Learning Steps in developing a Machine Learning Application. **Self-Learning Topics :** Real world case studies on machine learning	**08**	CO6

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.
2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition.
3. Howard J. Seltman, Experimental Design and Analysis, Carnegie Mellon University, 2012/1.
4. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press

References:

1. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
2. George Lugar, AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.
3. Data Science & Big Data Analytics, 1st Edition, 2015, EMC Education Services, Wiley. ISBN: 978-1118876138
4. Tom M.Mitchell “Machine Learning” McGraw Hill
5. Richard I. Levin, David S. Rubin “Statistics for Management” Pearson
6. Vivek Belhekar, “Statistics for Psychology using R” SAGE

Online References:

Sr. No.	Website/Reference link
1.	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs83/
2.	https://nptel.ac.in/courses/106/105/106105077/
3.	https://www.coursera.org/specializations/jhu-data-science
4.	https://www.coursera.org/learn/machine-learning
5.	https://www.udemy.com/course/statistics-for-data-science-and-business-analysis/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITL601	Business Intelligence Lab	--	02	--	01	01

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITL601	Business Intelligence Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage
2	To enable students to effectively identify sources of data and process it for data mining
3	To make students well versed in all data mining algorithms, methods, and tools.
4	To learn how to gather and analyze large sets of data to gain useful business understanding.
5	To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.
6	To identify and compare the performance of business.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Identify sources of Data for mining and perform data exploration	L2
2	Organize and prepare the data needed for data mining algorithms in terms of attributes and class inputs, training, validating, and testing files	L2
3	Implement the appropriate data mining methods like classification, clustering or association mining on large data sets using open-source tools like WEKA	L3

4	Implement various data mining algorithms from scratch using languages like Python/ Java etc.	L3
5	Evaluate and compare performance of some available BI packages	L3, L4
6	Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support	L3, L4

Prerequisite: Object oriented Concept, Java programming language, Python.

Hardware & Software Requirements:

Hardware Requirements	**Software Requirements**
PC i3 processor and above	Open source data mining and BI tools like WEKA, Rapid Miner, Pentaho

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	**--**	----	--
I	I	Tutorial on a) Design Star and Snowflake Schema	**02**	LO 1
II	II	Implement using tools or languages like JAVA/ python/R a) Data Exploration b) Data preprocessing	**04**	LO 2
III	III	Implement and evaluate using languages like JAVA/ python/R a) Classification Algorithms b) Clustering Algorithms c) Frequent Pattern Mining Algorithms	**06**	LO4
IV	IV	Perform and evaluate using any open-source tools a) Classification Algorithms b) Clustering Algorithms c) Frequent Pattern Mining Algorithms	**04**	LO3
V	V	Detailed case study of any one BI tool such as Pentaho, Tableau and QlikView	**04**	LO5
VI	VI	Business Intelligence Mini Project: Each group assigned one new case study for this A BI report must be prepared outlining the following steps: a) Problem definition, identifying which data mining task is needed b) Identify and use a standard data mining dataset available for the problem. Some links for data mining datasets are: WEKA, Kaggle, KDD cup, Data Mining Cup, UCI Machine Learning Repository etc. c) Implement appropriate data mining algorithm d) Interpret and visualize the results	**06**	LO6

		e) Provide clearly the BI decision that is to be taken as a result of mining		

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 1st Edition, Wiley India.
3. Paulraj Ponniah “Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals” Wiley Publications

References:

1. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education
2. WEKA, RapidMiner Pentaho resources from the Web.
3. https://www.kaggle.com/learn/overview
4. Python for Data Science https://onlinecourses.nptel.ac.in/noc21_cs33/preview

Term Work: Term Work shall consist of at least 10 racticals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks (Mini Project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL602	Web Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL602	Web Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Open Source Tools for Web Analytics and Semantic Web.
2	Programming in TypeScript for designing Web Applications.
3	AngularJS Framework for Single Page Web Applications.
4	AJAX for Rich Internet Applications.
5	REST API and MongoDB for Frontend and Backend Connectivity.
6	Flask Framework for building web applications.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Understand open source tools for web analytics and semantic web apps development and deployment.	L1, L2
2	Understand the basic concepts of TypeScript for designing web applications.	L1, L2, L3
3	Implement Single Page Applications using AngularJS Framework.	L1, L2, L3

4	Develop Rich Internet Applications using AJAX.	L1, L2, L3
5	Create REST Web services using MongoDB.	L1, L2, L3, L4
6	Design web applications using Flask.	L1, L2, L3, L4

Prerequisite: HTML/HTML5, CSS/CSS3, JavaScript, Python

Hardware & Software requirements:

Hardware Specifications	**Software Specifications**
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Angular IDE, Visual Studio Code, Notepad++, Python Editors, MySQL, XAMPP, MongoDB, JDK

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Web Analytics & Semantic Web	Study **Any 1** tool in each 1. Study web analytics using open source tools like Matomo, Open Web Analytics, AWStats, Countly, Plausible. 2. Study Semantic Web Open Source Tools like Apache TinkerPop, RDFLib, Apache Jena, Protégé, Sesame.	**02**	LO1
II	TypeScript	Perform **Any 3** from the following 1. Small code snippets for programs like Hello World, Calculator using TypeScript. 2. Inheritance example using TypeScript 3. Access Modifiers example using TypeScript 4. Building a Simple Website with TypeScript	**04**	LO2
III	AngularJS	Perform **Any 2** from the following 1. Create a simple HTML “Hello World” Project using AngularJS Framework and apply ng-controller, ng-model and expressions. 2. Events and Validations in AngularJS. (Create functions and add events, adding HTML validators, using $valid property of Angular, etc.) 3. Create an application for like Students Record using AngularJS	**06**	LO3
IV	Rich Internet Application using AJAX	Perform **Any 3** from the following 1. Write a JavaScript program for a AJAX. 2. Write a program to use AJAX for user validation using and to show the result on the same page below the submit button.	**06**	LO4

		3. Design and develop small web application using AJAX, HTML and JSP.		
V	MongoDB and Building REST API using MongoDB	Perform **Any 1** from the following 1. Build a RESTful API using MongoDB. 2. Build a TypeScript REST API using MongoDB.	**04**	LO5
VI	Flask	Perform **Any 3** from the following 1. Design Feedback Form using Flask. 2. Design Weather App using Flask. 3. Design Portfolio Website using Flask. 4. Create a complete Machine learning web application using React and Flask.	**04**	LO6

Text Books:

1. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, “Semantic Web Programming”, Wiley Publishing, Inc, 1st Edition, 2009.
2. Boris Cherny, “Programming TypeScript- Making Your Javascript Application Scale”, O’Reilly Media Inc., 2019 Edition.
3. Adam Bretz and Colin J. Ihrig, “Full Stack JavaScript Development with MEAN”, SitePoint Pty. Ltd., 2015 Edition.
4. Simon Holmes Clive Harber, “Getting MEAN with Mongo, Express, Angular, and Node”, Manning Publications, 2019 Edition.
5. Dr. Deven Shah, “Advanced Internet Programming”, StarEdu Solutions, 2019 Edition.
6. Miguel Grinberg, “Flask Web Development: Developing Web Applications with Python”, O’Reilly, 2018 Edition.

References:

1. John Davies, Rudi Studer and Paul Warren, “Semantic Web Technologies Trends and Research in Ontology-based Systems”, Wiley, 2006 Edition.
2. Yakov Fain and Anton Moiseev, “TypeScript Quickly”, Manning Publications, 2020 Edition.
3. Steve Fenton, “Pro TypeScript: Application - Scale Javascript Development”, Apress, 2014 Edition.
4. Brad Dayley, Brendan Dayley, Caleb Dayley, “Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications”, 2nd Edition, Addison-Wesley Professional, 2018 Edition.

Term Work:
Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term Work Journal must include at least 2 assignments.
Term Work Marks:
25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL603	Sensor Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL603	Sensor Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn various communication technologies, Microcontroller boards and sensors.
2	Design the problem solution as per the requirement analysis done using sensors and technologies.
3	Study the basic concepts of programming/sensors/ emulators.
4	Design and implement the mini project intended solution for project based earning.
5	Build, test and report the mini project successfully.
6	Improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Differentiate between various wireless communication technologies based on the range of communication, cost, propagation delay, power and throughput.	L1,L2

2	Conduct a literature survey of sensors used in real world wireless applications.	L1,L2
3	Demonstrate the simulation of WSN using the Network Simulators (Contiki/ Tinker CAD/ Cup carbon etc).	L1,L2,L3
4	Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing	L1,L2,L3
5	Report and present the findings of the study conducted in the preferred domain.	L1,L2,L3
6	Demonstrate the ability to work in teams and manage the conduct of the research study.	L1,L2,L3

Prerequisite: Computer Networks, Microprocessor Lab.

Hardware & Software requirements:

Hardware Specifications:	**Software Specifications:**
1.Laptop/ PC with minimum 2GB RAM and 500 GB Hard disk drive. 2. Sensors –DHT11/22, PIR, MQ2/MQ3, HC-SR04, Moisture sensor , Arduino Uno/Mega board, RPi Board 3. Wireless Radio Modules- Zigbee RF module, Bluetooth Module (HC-05), Mobile Phone with Bluetooth antenna 4. Others-Breadboard, wires, power supplies, USB cables, buzzers, LEDs, LCDs.	1. Windows or Linux Desktop OS Arduino IDE 2.XCTU configuration and test utility software 3. CupCarbon IOT simulator 4. Tinkercad Simulation Software 5. Contiki/Cooja 6. Internet connection

Guidelines

A. **Students should perform the following experiments:**

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction to 8086, 8051 and Python programming	**02**	--
I	Review of Wireless Communication Technologies	Study of various wireless communication technologies like IEEE 802.15.1, IEEE 802.15.4 and IEEE 802.11. Mini Project: Allocation of the groups	**02**	LO1
II	Sensors and their Interfacing	Study of various types of sensors and display devices (eg. DHT-11/22, HC-SR04, MFRC 522, PIR Sensor) and demonstration of their interfacing using Arduino/ Raspberry pi. Mini Project: Topic selection	**02**	LO2
III	Wireless Communication tools	Installation and testing the simulation tools (eg. TinkerCad/Cupcarbon/ContikiCooja). Mini Project: Topic validation and finalizing software and Hardware requirement.	**02**	LO3
IV	Implementation of Wireless Technologies	Study of interfacing of Arduino/ Raspberry pi with Wireless Technologies (eg. HC-05, XBee S2C by	**02**	LO4

		Digi, ESP controller). Mini Project: Hardware procurement		
V	Remote Access	Study of interface using Mobile/Web to publish or remotely access the data on the Internet. Mini Project: Study of remote access technologies with respect to the selected project.	**02**	LO4
VI	Mini Project	Implementation of the Mini Project: 1. Design, configure, testing the Mini Project. 2. Report submission as per the guidelines.	**14**	LO4,LO5,LO6

B. Mini project

1. Students should carry out hardware based mini-project in a group of three/four students with a subject In charge/ mini project mentor associated with each group.
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, configure and test their own circuit board.
5. Interface using Mobile/Web to publish or remotely access the data on the Internet.
6. A detailed report is to be prepared as per guidelines.
7. Each group may present their work in various project competitions and paper presentations

C. Documentation of the Mini Project

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Wireless Technology used)
5. Chapter-2 (System design/Block diagram, Flow chart, Circuit/Interfacing diagram, Hardware and Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Fundamentals of Sensor Network Programming: Applications and Technology, S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley Publications.
2. ContikiCooja User Guide.
3. Building Wireless Sensor Networks, Robert Faludi, O’Reilly Publications.

Reference Books:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , ArshdeepBahga.
2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009.
3. Wireless Sensor Networks-Technology, Protocols and Applications, KazemSohraby, Daniel Minoli and TaiebZnati, Wiley Publications.
4. Adhoc& Sensor Networks Theory and Applications, Carlos de MoraisCordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.

Online References:

Sr. No.	**Website/Reference link**
1.	https://www.digi.com/resources/documentation/digidocs/90001526/tasks/t_download_and_install_xctu.htm
2.	https://www.arduino.cc/en/software
3.	http://cupcarbon.com/

Term Work:

Term Work shall consist of Mini Project on above guidelines/syllabus. Also Term work must include at least 2 assignments and mini project report.

Term Work Marks: 25 Marks (Total marks) =15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL604	MAD & PWA Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn the basics of the Flutter framework.
2	Develop the App UI by incorporating widgets, layouts, gestures and animation
3	Create a production ready Flutter App by including files and firebase backend service.
4	Learn the Essential technologies, and Concepts of PWAs to get started as quickly and efficiently as possible
5	Develop responsive web applications by combining AJAX development techniques with the jQuery JavaScript library.
6	Understand how service workers operate and also learn to Test and Deploy PWA.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On Completion of the course the learner/student should be able to:		
1	Understand cross platform mobile application development using Flutter framework	**L1, L2**
2	Design and Develop interactive Flutter App by using widgets, layouts, gestures and animation	**L3**
3	Analyze and Build production ready Flutter App by incorporating backend services and deploying on Android / iOS	**L3, L4**
4	Understand various PWA frameworks and their requirements	**L1, L2**
5	Design and Develop a responsive User Interface by applying PWA Design techniques	**L3**
6	Develop and Analyse PWA Features and deploy it over app hosting solutions	**L3, L4**

Prerequisite: HTML/HTML5, CSS3, Javascript

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	**JDK 8 and above, Android studio, Flutter SDK, AngularJs, React, Vue, PWA Builder, Google Chrome Browser, Github account.** **Internet Connection**

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**

I	Basics of Flutter Programming	Introduction of Flutter, Understanding Widget Lifecycle Events,Dart Basics, Widget Tree and Element Tree, Basics of Flutter installation, Flutter Hello World App.	**02**	LO1
II	Developing Flutter UI:Widgets, Layouts, Gestures, Animation	**USING COMMON WIDGETS:** SafeArea, Appbar, Column, Row, Container, Buttons, Text , Richtext,Form ,Images and Icon. **BUILDING LAYOUTS** : high level view of layouts, Creating the layout, Types of layout widgets **APPLYING GESTURES**: Setting Up GestureDetector, Implementing the Draggable and Dragtarget Widgets,Using the GestureDetector for Moving and Scaling **ADDING ANIMATION TO AN APP** :Using Animated Container,Using Animated CrossFade,Using Animated Opacity,Using Animation Controller, Using Staggered Animation **CREATING AN APP'S NAVIGATION:** Using the Navigator,Using the Named Navigator Route,Using the Bottom NavigationBar,Using the TabBar and TabBarView	**06**	LO2
III	Creating Production Ready Apps	**Working with files** : Including libraries in your Flutter app, Including a file with your app, Reading/Writing to files, Using JSON. **Using Firebase with Flutter**: Adding the Firebase and Firestore Backend,Configuring the Firebase Project,Adding a Cloud Firestore Database and Implementing Security **Testing and Deploying of Flutter Application:** Widget testing, Deploying Flutter Apps on Android / iOS	**04**	LO3
IV	Introduction to Progressive Web App	**Introduction to Progressive Web App** ● Why Progressive Web App ● Characteristics of PWA ● PWAs and Hybrid Apps vs. Mobile Apps ● PWA Requirements: HTTPS, Service Workers, and Web App Manifest ● PWA framework tools ● Use cases	**02**	LO4

V	Creating Responsive UI	**Creating Responsive UI using JQuery Mobile / Material UI / Angular UI / React UI** ● Understanding the concept of responsive web design ● Comparing responsive, fluid, and adaptive web ● keys to great Progressive Web App UX ● Responsive Design – The Technicalities ● Flexible grid-based layout ● Flexible images and video ● Smart use of CSS splitting the website behavior (media queries)	06	LO5
VI	Web App Manifest & Service Workers	**Web App Manifest:** Understand the basic format and workings of the Web App Manifest file. ● Using an App Manifest to Make your App Installable ● Understanding App Manifest Properties ● Simulating the Web App on an Emulator ● Installing the Web App - Prerequisites ● Understanding manifest.json **Service Workers:** Making PWAs work offline with Service workers ● Introduction to Service Workers ● Service Workers Lifecycle (Registration, Installation and Activation) ● Implement Service Workers Features (Events) ● Handling cached content ● Enabling offline functionality ● Serving push notifications ● Loading cached content for new users ● Background synchronization ● Using IndexedDB in the Service Worker ● Geo-fencing **Deploy a PWA to GitHub Pages as a free SSL enabled static app hosting solution.** ● Initialising the PWA as a Git repo ● Testing with Lighthouse ● Deploying via GitHub Pages	06	LO6

Text Books:

1. Beginning Flutter a Hands-on Guide to App Development, Marco L. Napoli, Wiley, 2020.
2. Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, By Rap Payne, 2019
3. Progressive Web Application Development by Example: Develop fast, reliable, and engaging user experiences for the web, Packt Publishing Limited ,2018
4. Building Progressive Web Apps,O’Reilly 2017

5. Progressive Web Apps with Angular: Create Responsive, Fast and Reliable PWAs Using Angular, Apress; 1st ed. edition (28 May 2019)

References:

1. Flutter in Action by Eric Windmill, MANING, 2019
2. Google Flutter Mobile Development Quick Start Guide.Packt,2019
3. Learning Progressive Web Apps: Building Modern Web Apps Using Service Workers ,Addison-Wesley Professional, 2020

Online References:

Sr. No.	Website/Reference link
1.	https://flutter.dev/docs/reference/tutorials
2.	**https://www.tutorialspoint.com/flutter/index.htm**
3.	**https://www.javatpoint.com/flutter**
4.	https://www.tutorialspoint.com/jquery_mobile/jqm_panel_responsive.htm
5.	https://www.w3schools.com/css/css_rwd_intro.asp
6	https://developers.google.com/web/updates/2015/12/getting-started-pwa
7	https://www.w3schools.com/react/
8	https://angular.io/docs
9	https://flaviocopes.com/service-workers/
10	https://blog.logrocket.com/how-to-build-a-progressive-web-app-pwa-with-node-js/

List of Experiments.

1. To install and configure Flutter Environment.
2. To design Flutter UI by including common widgets.
3. To create an interactive Form using form widget
4. To design a layout of Flutter App using layout widgets
5. To include icons, images, charts in Flutter app
6. To apply navigation, routing and gestures in Flutter App
7. To Connect Flutter UI with fireBase database
8. To test and deploy production ready Flutter App on Android platform
9. To create a responsive User Interface using jQuery Mobile/ Material UI/ Angular UI/ React UI for Ecommerce application.
10. To write meta data of your Ecommerce PWA in a Web app manifest file to enable “add to homescreen feature”.
11. To code and register a service worker, and complete the install and activation process for a new service worker for the E-commerce PWA.
12. To implement Service worker events like fetch, sync and push for E-commerce PWA.
13. To study and implement deployment of Ecommerce PWA to GitHub Pages.
14. To use google Lighthouse PWA Analysis Tool to test the PWA functioning.
15. To deploy an Ecommerce PWA using SSL enabled static hosting solution.

Assignment 1: MAD (Any one)

1. To Study basics of Dart language and design basic Flutter App
2. To include Files and JSON data in App
3. To build interactive App by including Flutter Gestures and Animations

Assignment 2: PWA (Any one)

1. To study the requirement for progressive web application for Ecommerce using the concept of service worker, Webapp Manifest and framework tools
2. To Design a wireframe for simple PWA for E-commerce website
3. Case study for successful real life implementation of PWA.

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term Work Journal must include at least 2 assignments as mentioned in above syllabus.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITL605	DS using Python Lab	--	02	--	01	01

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract / Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ITL605	DS using Python Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To know the fundamental concepts of data science and analytics
2	To learn data collection, preprocessing and visualization techniques for data science
3	To Understand and practice analytical methods for solving real life problems based on Statistical analysis
4	To learn various machine learning techniques to solve complex real-world problems
5	To learn streaming and batch data processing using Apache Spark
6	To map the elements of data science to perceive information

Lab Outcomes:

Sr. No.	Lab Outcomes	**Cognitive levels of attainment as per Bloom's Taxonomy**

On successful completion, of course, learner/student will be able to:		
1	Understand the concept of Data science process and associated terminologies to solve real-world problems	L1
2	Analyze the data using different statistical techniques and visualize the outcome using different types of plots.	L1, L2, L3, L4
3	Analyze and apply the supervised machine learning techniques like Classification, Regression or Support Vector Machine on data for building the models of data and solve the problems.	L1,L2, L3, L4
4	Apply the different unsupervised machine learning algorithms like Clustering, Decision Trees, Random Forests or Association to solve the problems.	L1, L2,L3
5	Design and Build an application that performs exploratory data analysis using Apache Spark	L1,L2,L3,L4,L5,L6
6	Design and develop a data science application that can have data acquisition, processing, visualization and statistical analysis methods with supported machine learning technique to solve the real-world problem	L1,L2,L3,L4,L5,L6

Prerequisite: Basics of Python programming and Database management system.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
I	Introduction to Data Science and Data Processing using Pandas	i. Introduction, Benefits and uses of data science ii. Data Science tasks iii. Introduction to Pandas iv. Data preparation: Data cleansing, Data transformation, Combine/Merge /Join data, Data loading & preprocessing with pandas v. Data aggregation vi. Querying data in Pandas vii. Statistics with Pandas Data Frames viii. Working with categorical and text data ix. Data Indexing and Selection x. Handling Missing Data	**04**	LO1
II	Data Visualization and Statistics	i. Visualization with Matplotlib and Seaborn ii. Plotting Line Plots, Bar Plots, Histograms Density Plots, Paths, 3Dplot, Stream plot, Logarithmic plots, Pie chart, Scatter Plots and Image visualization using Matplotlib iii. Plotting scatter plot, box plot, Violin plot, swarm plot, Heatmap, Bar Plot using seaborn iv. Introduction to scikit-learn and SciPy v. Statistics using python: Linear algebra, Eigen value, Eigen Vector, Determinant, Singular Value Decomposition, Integration, Correlation, Central Tendency, Variability, Hypothesis testing, Anova, z-test, t-test and chi-square test.	**04**	LO2
III	Machine Learning	i. What is Machine Learning? ii. Applications of Machine Learning; iii. Introduction to Supervised Learning iv. Overview of Regression v. Support Vector Machine vi. Classification algorithms	**05**	LO3

IV	Unsupervised Learning	i. Introduction to Unsupervised Learning ii. Overview of Clustering iii. Decision Trees iv. Random Forests v. Association	**05**	LO4
V	Data analytics using Apache Spark	i. Introduction to Apache Spark ii. Architecture of Apache Spark iii. Modes and components iv. Basics of PySpark	**04**	LO5
VI	Case Studies	i. Understanding the different data science phases used in selected case study ii. Implementation of Machine learning algorithm for selected case study	**04**	LO1, LO6

Text Books:

1. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly publication
2. Frank Kane, “Hands-On Data Science and Python Machine Learning”, packt publication
3. M.T. Savaliya, R.K. Maurya, G.M.Magar, “Programming with Python”, 2nd Edition, Sybgen Learning.

References:

1. Armando Fandango, “Python Data Analysis”, Second Edition, Packt publication.
2. Alberto Boschetti, Luca Massaron, “Python Data Science Essentials Second Edition”, Packt Publishing
3. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, “Introducing Data Science”, Manning Publications.

Online References:

Sr. No.	Website/Reference link
1.	https://www.w3schools.com/python/pandas/default.asp
2.	https://matplotlib.org/stable/gallery/index.html
3.	. https://seaborn.pydata.org/examples/index.html
4.	. https://docs.scipy.org/doc/scipy/reference/linalg.html#module-scipy.linalg
5.	https://scikit-learn.org/stable/auto_examples/index.html
6	https://www.tutorialspoint.com/scipy/scipy_integrate.htm\
7	https://machinelearningmastery.com/statistical-hypothesis-tests-in-python-cheat-sheet/
8	https://data-flair.training/blogs/data-science-project-ideas/

Suggested List of Experiments

For the following Experiments, use any available data set or download it from Kaggle/UCI or other repositories and use Python to solve each problem.

1. Data preparation using NumPy and Pandas
    a. Derive an index field and add it to the data set.
    b. Find out the missing values.
    c. Obtain a listing of all records that are outliers according to the any field. Print out a listing of the 10 largest values for that field.
    d. Do the following for the any field.
        i. Standardize the variable.
        ii. Identify how many outliers there are and identify the most extreme outlier.

2. Data Visualization / Exploratory Data Analysis for the selected data set using Matplotlib and Seaborn
    a. Create a bar graph, contingency table using any 2 variables.
    b. Create normalized histogram.
    c. Describe what this graphs and tables indicates?
3. Data Modeling
    a. Partition the data set, for example 75% of the records are included in the training data set and 25% are included in the test data set. Use a bar graph to confirm your proportions.
    b. Identify the total number of records in the training data set.
    c. Validate your partition by performing a two-sample Z-test.
4. Implementation of Statistical Hypothesis Test using Scipy and Sci-kit learn [Any one]

1. Normality Tests
    1. Shapiro-Wilk Test
    2. D'Agostino's K^2 Test
    3. Anderson-Darling Test
2. Correlation Tests
    1. Pearson's Correlation Coefficient
    2. Spearman's Rank Correlation
    3. Kendall's Rank Correlation
    4. Chi-Squared Test
3. Stationary Tests
    1. Augmented Dickey-Fuller
    2. Kwiatkowski-Phillips-Schmidt-Shin
4. Parametric Statistical Hypothesis Tests
    1. Student's t-test
    2. Paired Student's t-test
    3. Analysis of Variance Test (ANOVA)
    4. Repeated Measures ANOVA Test
5. Nonparametric Statistical Hypothesis Tests
    1. Mann-Whitney U Test
    2. Wilcoxon Signed-Rank Test
    3. Kruskal-Wallis H Test
    4. Friedman Test

5. Regression Analysis
    a. Perform Logistic Regression to find out relation between variables.
    b. Apply regression Model techniques to predict the data on above dataset

6. Classification modelling
    a. Choose classifier for classification problem.
    b. Evaluate the performance of classifier.
7. Clustering
    a. Clustering algorithms for unsupervised classification.
    b. Plot the cluster data.
8. Using any machine learning techniques using available data set to develop a recommendation system.

9. Exploratory data analysis using Apache Spark and Pandas
10. Batch and Streamed Data Analysis using Spark
11. Implementation of Mini project based on following case study using Data science and Machine learning [Any one]

List of Case Studies		
Fake News Detection	Road Lane Line Detection	Sentiment Analysis
Detecting Parkinson’s Disease	Brain Tumor Detection with Data Science	Leaf Disease Detection
Speech Emotion Recognition	Gender Detection and Age prediction	Diabetic Retinopathy
Uber Data Analysis	Driver Drowsiness detection	Chatbot Project
Credit Card Fraud Detection	Movie/ Web Show Recommendation System	Customer Segmentation
Cancer Classification	Traffic Signs Recognition	Exploratory Data Analysis for Housing price prediction
Coronavirus visualizations	Visualizing climate change	Predictive policing
Uber’s pickup analysis	Earth Surface Temperature Visualization	Web traffic forecasting using time series
Pokemon Data Exploration	Impact of Climate Change on Global Food Supply	Used Car Price Estimator
Skin Cancer Image Detection	World University Rankings	and so on ….

Assignments:

1) Recent trends in Data science
2) Comparative analysis between Batch and Streamed data processing tools like Map-reduce, Apache spark, Apache Flink, Apache Samza, Apache Kafka and Apache Storm.

Term Work:

- Term work shall consist of at least 10 experiments and a case study.
- Journal must include 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.
- The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) ………… (15) Marks.
- Mini project (Implementation) ………… . (05) Marks.
- Attendance………………………………. (05) Marks

TOTAL:………………………………….(25) Marks.

Oral examination will be based on Laboratory work, mini project and above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM601	Mini Project – 2 B Web Based on ML	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM601	Mini Project – 2 B Based on ML	--	--	--	--	25	25	50

Course Objectives

5. To acquaint with the process of identifying the needs and converting it into the problem.
6. To familiarize the process of solving the problem in a group.
7. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
8. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

10. Identify problems based on societal /research needs.
11. Apply Knowledge and skill to solve societal problems in a group.
12. Develop interpersonal skills to work as member of a group or leader.
13. Draw the proper inferences from available results through theoretical/ experimental/simulations.
14. Analyse the impact of solutions in societal and environmental context for sustainable development.
15. Use standard norms of engineering practices
16. Excel in written and oral communication.
17. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
18. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book : 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

14. Quality of survey/ need identification
15. Clarity of Problem definition based on need.
16. Innovativeness in solutions
17. Feasibility of proposed problem solutions and selection of best solution
18. Cost effectiveness
19. Societal impact
20. Innovativeness
21. Cost effectiveness and Societal impact
22. Full functioning of working model as per stated requirements
23. Effective use of skill sets
24. Effective use of standard engineering norms
25. Contribution of an individual's as member or leader
26. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

9. Quality of problem and Clarity
10. Innovativeness in solutions
11. Cost effectiveness and Societal impact
12. Full functioning of working model as per stated requirements
13. Effective use of skill sets
14. Effective use of standard engineering norms
15. Contribution of an individual's as member or leader
16. Clarity in written and oral communication

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITDO6011	Software Architecture	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO6011	Software Architecture	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the importance of architecture in building effective, efficient, competitive software products.
2	To understand the need, design approaches for software architecture to bridge the dynamic requirements and implementation
3	To learn the design principles and to apply for large scale systems including distributed, network and heterogeneous systems
4	To understand principal design decisions governing the system.
5	To understand different notations used for capturing design decisions.
6	To understand different functional and non-functional properties of complex software systems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy

On successful completion, of course, learner/student will be able to:		
1	Understand the need of software architecture for sustainable dynamic systems.	L1
2	Have a sound knowledge on design principles and to apply for large scale systems.	L2
3	Apply functional and non-functional requirements	L1,L2,L3
4	Design architectures for distributed, network and heterogeneous systems	L1,L2,L3
5	Have good knowledge on service oriented and model driven architectures and the aspect-oriented architecture.	L1,L2, L3
6	Have a working knowledge to develop appropriate architectures through various case studies.	L1,L2, L3

Prerequisite: Software Engineering, Any Programming Language

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Software Engineering Concepts, Knowledge of Any programming Language	**02**	CO1
I	Basic Concepts and Architectures Design	Terminology, Models, Processes, Stakeholders, Design Process, Architectural Conceptions, Styles and architectural Patterns, Architectural conceptions in absences of experience, connectors, 4+1 view model of Architecture **Self Learning Topics** : Technical Paper "What_is_included_in_software_architectur"	**07**	CO1
II	Architectural Modeling and Analysis	Modeling Concepts, Ambiguity, Accuracy and Precisions, Complex Modeling, Evaluating Modeling Techniques, Specific Modeling Techniques, Analysis Goals, Scope of Analysis, Formality of Architectural Models, Types of Analysis, Level of Automation, System Stakeholders, Analysis Techniques **Self Learning Topics:** Technical Paper "Specification of Requirements and Software Architecture for the Customisation of Enterprise Software"	**09**	CO1, CO2
III	Implementation, Deployment and Mobility	Implementation Concepts, Existing Frameworks, Overview of Deployment and Mobility Challenges, Software Architecture and Deployment, Software Architecture and Mobility **Self Learning Topics:** Technical Paper"Application of Distributed System in Neuroscience: A Case Study of BCI Framework"	**06**	CO1, CO2
IV	Applied Architectures and Styles	Distributed and Network Architectures, Architectures for Network Based Applications, Decentralized Architectures, Service oriented Architectures and Web Services. **Self Learning Topics:**Technical Paper "Analysing the Behaviour of Distributed Software Architectures: a Case Study"	**06**	CO1, CO2, CO3

V	Designing for Non-Functional Properties	Efficiency, Complexity, Scalability and Heterogeneity, Adaptability, Dependability **Self Learning Topics:** Technical Paper “Threat-Modeling-in-Agile-Software-Development”	**04**	CO1,CO2, CO4, CO6
VI	Domain-Specific Software Engineering	Domain-Specific Software Engineering, Domain- Specific Architecture, Software Architects Roles **Self Learning Topics**: Research Paper “A Case Study of the Variability Consequences of the CQRS”	**05**	CO1,CO2, CO3

Text Books:

1. Software Architecture, Foundations, Theory, and Practise, Richard Taylor, Nenad Medvidovic, Eric M Dashofy, Wiley Student Edition.
2. The Art of Software Architecture: Design Methods and Techniques, Stephen T.Albin, Wiley India Private Limited.
3. Software Architecture in Practice by Len Bass, Paul Clements, Rick Kazman, Pearson

References:

1. DevOps A Software Architect’s Perspective, Len Bass, Ingo Weber, Liming Zhu, Addison Wesley
2. Essentials of Software Architecture, Ion Gorton, Second Edition, Springer-verlag, 2011

Online Resources:

1. ArchStudio Software
2. https://www.coursera.org/learn/software-architecture
3. https://www.coursera.org/specializations/software-design-architecture
4. https://resources.sei.cmu.edu/library/asset-view.cfm?assetid=509483
5. http://infolab.stanford.edu/~backrub/google.html
6. https://web.njit.edu/~alexg/courses/cs345/OLD/F15/solutions/f3345f15.pdf

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6012	Image Processing	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ITDO6012	Image Processing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Define image and its formation and debate about the roles of image processing in today's world and also introduce students to the major research domains in the field of image processing.
2	Describe point, mask and histogram processing units of image enhancements that can be applied on a given image for improving the quality of digital image required for an application.
3	Explain the forward and reverse discrete image transforms and discuss the selection of the image transform used for enhancement, compression, or representation and description.
4	Make students understand the impacts and effects of image compression techniques over a given bandwidth to learn how effectively storage and retrieval can be achieved using lossy and lossless compression methods.
5	Describe and demonstrate the proper procedure for segmenting images, and demonstrate how the image object can be described using image representation techniques.
6	Illustrate how to shape and reshape a given object in an image using morphological techniques over binary and gray scale images.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define image and explain formation of image and recall its types and calculate image parameters by reading images using a programming language.	L1
2	Apply and differentiate point, mask and histogram processing techniques suitable for enhancing images required for an application.	L1,L2,L3
3	List and calculate discrete image transform coefficients and use it for enhancement, compression and representation.	L1,L2, L3
4	Compute compression ratio and fidelity criteria to evaluate and compare method efficiency and classify compression techniques into lossless and lossy methods.	L1,L2,L3, L4
5	Apply the segmentation techniques to highlight and select the region of interest and determine and describe using chain code, shape number and moments for representing objects in an image.	L1,L2,L3
6	Choose structuring elements and apply morphological operations to find a suitable shape for an object in the image.	L1,L2,L3

Prerequisite: Digital Signal Processing.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Digital Signal Processing, Matrix Multiplication.	**01**	
I	Introduction to Image Processing	**Image Fundamentals:** Image Definition, Steps and Components of Image Processing, Image Sensing and Acquisition, Image Sampling and Quantization. **Relationship Between Pixels:** Adjacency, Connectivity and Distance. **Self-Learning Topics:** Different Image File Formats and Types of noise in image.	**04**	CO1
II	Image Enhancement	**Point Processing Techniques**: Image Negative, Bit Plane Slicing, Gray Level Slicing, Contrast Stretching, Clipping, Thresholding, Dynamic Range Compression. **Mask Processing Techniques:** Filtering in Spatial Domain, Average Filter, Weighted Average Filter, Order Statistic Filter: Min, Max, Median Filter. **Histogram Processing:** Histogram Equalization and Specification. **Self-Learning Topics:** Application of Image Enhancement in Spatial Domain.	**08**	CO2
III	Image Transforms	**Discrete Fourier Transform:** Transform Pair, Transform Matrix, Properties, Filtering in Frequency Domain. **Other Discrete Transforms:** Discrete Cosine Transform, Discrete Hadamard Transform, Discrete Walsh, Transform, Discrete Haar Transform.	**07**	CO3

		Self-Learning Topics: Application of Transforms in Steganography and CBIR.		
IV	Image Compression	Entropy, Redundancy and Types, Compression Ratio, Compression Methods. **Lossless Compression:** Run-Length Encoding, Huffman Coding, Arithmetic Coding, LZW Coding, Lossless Predictive coding. **Lossy Compression**: Fidelity Criterion, Improved Gray scale Quantization**,** Symbol-Based Coding, Bit-Plane Coding, Vector Quantization. **Self-Learning Topics:** DPCM, Block Transform Coding, JPEG compression.	**07**	CO4
V	Image Segmentation and Representation	**Image Segmentation:** Point, Line and Edge Detections Methods, Hough Transform, Graph Theoretic Method, Region Based Segmentation. **Image Representation:** Chain Codes, Shape Number, Polygon Approximation, Statistical Moments. **Self-Learning Topics:** Fourier Descriptors, Otsu Thresholding, Application in Number Plate Recognition.	**07**	CO5
VI	Morphological Image Processing	**Basic Morphological Methods:** Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation. **Advanced Morphological Methods:** Skeletonization, Thinning, Thickening, Pruning, Boundary Extraction. **Self-Learning Topics:** Gray Scale Morphology: Erosion and Dilation.	**05**	CO6

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Addison - Wesley Publishing Company, 3e, 2007.
2. William K. Pratt, “Digital Image Processing”, John Wiley, 4e, 2007.
3. S. Jayaraman, S. Esakkirajan and T. Veerakumar, “Digital Image Processing”, MGH Publication, 2016.

References:

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing using MATLAB,” Pearson Education.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal processing Principles, Algorithms and Applications,” PHI Publications, 3e.
3. Anil K. Jain, “Fundamentals of Digital Image Processing,” PHI, 1995.
4. Milan Sonka, “Digital Image Processing and Computer Vision,” Thomson publication, Second Edition.2007.
5. Kenneth R. Castleman, “Digital Image Processing,” PHI, 1996.
6. S. Sridhar, “Digital Image Processing,” Oxford University Press, 2e, 2016.

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
  - A total of **four questions** need to be answered

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
ITDO6013	Green IT	03	--	03	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test1	**Test 2**	**Avg.**					
ITDO6013	Green IT	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand what Green IT is and How it can help improve environmental Sustainability
2	To understand the principles and practices of Green IT.
3	To understand how Green IT is adopted or deployed in enterprises.
4	To understand how data centres, cloud computing, storage systems, software and networks can be made greener.
5	To measure the Maturity of Sustainable ICT world.
6	To implement the concept of Green IT in Information Assurance in Communication and Social Media and all other commercial field.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		

1	Describe awareness among stakeholders and promote green agenda and green initiatives in their working environments leading to green movement	L1
2	Identify IT Infrastructure Management and Green Data Centre Metrics for software development	L1,L2
3	Recognize Objectives of Green Network Protocols for Data communication.	L1,L2
4	Use Green IT Strategies and metrics for ICT development.	L1,L2,L3
5	Illustrate various green IT services and its roles.	L1,L2
6	Use new career opportunities available in IT profession, audits and others with special skills such as energy efficiency, ethical IT assets disposal, carbon footprint estimation, reporting and development of green products, applications and services.	L1,L2,L3

Prerequisite: Environmental Studies

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Environmental Studies	2	
I	Introduction	Environmental Impacts of IT, Holistic Approach to Greening IT, Green IT Standards and Eco-Labeling, Enterprise Green IT Strategy **Hardware:** Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose **Software:** Introduction, Energy-Saving Software Techniques **Self learning Topics:** Evaluating and Measuring Software Impact to Platform Power	7	CO 1
II	Software development and data centers	Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics Data Centres and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, Green Data Centre Metrics **Self-learning Topics:** Sustainable Software: A Case Study, Data Centre Management Strategies: A Case Study	7	CO 1 CO 2
III	Data storage and communication	Storage Media Power Characteristics, Energy Management Techniques for Hard Disks Objectives of Green Network Protocols, Green Network Protocols and Standards **Self learning Topics:** System-Level Energy Management	6	CO 1 CO 3
IV	Information systems, green it strategy and metrics	Approaching Green IT Strategies, Business Drivers of Green IT Strategy Multilevel Sustainable Information,	6	CO 1 CO 4

		Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Measuring the Maturity of Sustainable ICT: A Capability Maturity Framework for SICT, Defining the Scope and Goal, Capability Maturity Levels **Self learning Topics:** Business Dimensions for Green IT Transformation		
V	Green IT services and roles	Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware **Self learning Topics:** Inter-organizational Enterprise Activities and Green Issues, Enablers and Making the Case for IT and the Green Enterprise	6	CO 1 CO 4 CO 5
VI	Managing and regulating green IT	Strategizing Green Initiatives, Implementation of Green IT, Communication and Social Media The Regulatory Environment and IT Manufacturers, Nonregulatory Government Initiatives, Industry Associations and Standards Bodies, Green Building Standards, Social Movements and Greenpeace. **Self learning Topics:** Information Assurance, Green Data Centers, Case Study: Managing Green IT	5	CO 1 CO 5 CO 6

Text Books:

1. San Murugesan, G. R. Gangadharan, Harnessing Green IT, WILEY 1st Edition-2013
2. Mohammad Dastbaz Colin Pattinson Babak Akhgar, Green Information Technology A Sustainable Approach, Elsevier 2015
3. Reinhold, Carol Baroudi, and Jeffrey HillGreen IT for Dummies, Wiley 2009

References:

1. Mark O'Neil, Green IT for Sustainable Business Practice: An ISEB Foundation Guide, BCS
2. Jae H. Kim, Myung J. Lee Green IT: Technologies and Applications, Springer, ISBN: 978-3-642-22178-1
3. Elizabeth Rogers, Thomas M. Kostigen The Green Book: The Everyday Guide to Saving the Planet One Simple Step at a Time, Springer

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6014	Ethical Hacking and Forensics	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ITDO6014	Ethical Hacking and Forensics	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concept of cybercrime and principles behind ethical hacking.
2	To explore the fundamentals of digital forensics, digital evidence and incident response.
3	To learn the tools and techniques required for computer forensics.
4	To understand the network attacks and tools and techniques required to perform network forensics.
5	To learn how to investigate attacks on mobile platforms.
6	To generate a forensics report after investigation.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define the concept of ethical hacking.	L1
2	Recognize the need of digital forensics and define the concept of digital evidence and incident response.	L1,L2
3	Apply the knowledge of computer forensics using different tools and techniques.	L1,L2,L3
4	Detect the network attacks and analyze the evidence.	L1, L2,L3,L4
5	Apply the knowledge of computer forensics using different tools and techniques.	L1,L2,L3
6	List the method to generate legal evidence and supporting investigation reports	L1,L2

Prerequisite: Computer Networks, Computer Network Security

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Networks, Computer Network Security	**01**	--
I	**Cybercrime and Ethical Hacking**	Introduction to Cybercrime, Types of Cybercrime, Classification of Cybercriminals, Role of computer in Cybercrime, Prevention of Cybercrime. Ethical Hacking, Goals of Ethical Hacking, Phases of Ethical Hacking, Difference between Hackers, Crackers and Phreakers, Rules of Ethical Hacking. **Self Learning Topics**: exploring various online hacking tools for Reconnaissance and scanning Phase.	**06**	CO1
II	**Digital Forensics Fundamentals**	Introduction to Digital Forensics, Need and Objectives of Digital Forensics, Types of Digital Forensics, Process of Digital Forensics, Benefits of Digital Forensics, Chain of Custody, Anti Forensics. Digital Evidence and its Types, Rules of Digital Evidences. Incident Response, Methodology of Incident Response, Roles of CSIRT in handling incident. **Self Learning Topics:** Pre Incident preparation and Incident Response process	**06**	CO2
III	**Computer Forensics**	Introduction to Computer Forensics, Evidence collection (Disk, Memory, Registry, Logs etc), Evidence Acquisition, Analysis and Examination(Window, Linux, Email, Web, Malware) , Challenges in Computer Forensics, Tools used in Computer Forensics.	**08**	CO3

		Self Learning Topics: Open source tool for Data collection & analysis in windows or Unix		
IV	**Network Forensics**	Introduction, Evidence Collection and Acquisition (Wired and Wireless), Analysis of network evidences(IDS, Router,), Challenges in network forensics, Tools used in network forensics. **Self Learning Topics:** IDS types and role of IDS in attack prevention	**08**	CO4
V	**Mobile Forensics**	Introduction, Evidence Collection and Acquisition, Analysis of Evidences, Challenges in mobile forensics, Tools used in mobile forensics **Self Learning Topics**: Tools / Techniques used in mobile forensics	**06**	CO5
VI	**Report Generation**	Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. **Self Learning Topics**: For an incident write a forensic report.	**04**	CO6

Text Books:

1. John Sammons, “The Basics of Digital Forensics: The Premier for Getting Started in Digital Forensics”, 2nd Edition, Syngress, 2015.
2. Nilakshi Jain, Dhananjay Kalbande, “Digital Forensic: The fascinating world of Digital Evidences” Wiley India Pvt Ltd 2017.
3. Jason Luttgens, Matthew Pepe, Kevin Mandia, “Incident Response and computer forensics”,3rd Edition Tata McGraw Hill, 2014.

References:

1. Sangita Chaudhuri, Madhumita Chatterjee, “Digital Forensics”, Staredu, 2019.
2. Bill Nelson,Amelia Phillips,Christopher Steuart, “Guide to Computer Forensics and Investigations” Cengage Learning, 2014.
3. Debra Littlejohn Shinder Michael Cross “Scene of the Cybercrime: Computer Forensics Handbook”, 2nd Edition Syngress Publishing, Inc.2008.

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

AC – _________
Item No. ______

UNIVERSITY OF MUMBAI

Syllabus for Ph.D. Course Work

(As per Credit Based Semester and Grading System with effect from the academic year 2021–2022)

Course Work Structure for Ph.D. Programme in Information Technology under Faculty of Science and Technology

University of Mumbai

(With effect from Academic Year 2021-22)

CODE	**NAME OF COURSE**	**CONTACT HOURS**	**CREDITS**	**EXAMINATION SCHEME**				
				MID TERM TEST	**END SEMESTER EXAM**	**TERM WORK**	**SEMINAR PRESENTATION**	**TOTAL**
PhD101	Research Methodology	60	4	25	75	--	--	100
PhD102	Course suggested by Guide*	60	4	25	75	--	--	100
PhD103	Course Organised by Research Centre (as per the research area)	60	4	25	75	--	--	100
PhD104	Seminar	-	4	-	-	--	100	100
Total		180	16	75	225	100	100	400

Grading of Research Candidates Performance

Awarding of grades to research candidates based on their performance shall be done as per the applicable ordinances and regulations for undergraduate and Post graduate programs of Engineering under the Faculty of Technology. Semester Grade Point Index (SGPI) shall be also calculated based on the ordinances and regulations applicable for engineering programs under Faculty of Technology. Approved and recognized Research Centers shall prepare Phd course work grade card after successful completion of course work and issue to candidates and one copy to University concerned section for record.

Course Code	Course Name	Credits
PhdIT101	**Research Methodology**	**06**

Module	**Detailed content**	**Hrs.**
I	**Research Methodology and Problem Identification and Formulation:** Meaning and objectives, motivation of research, types of research, research methods v/s methodology, research and scientific methods, research process and stages of research, defining and formulating the research problem, technique involved in defining a	12

	problem, importance of literature review in defining a problem, role of literature review, ways to perform literature review, methods to find open problem and research problems, critical literature review, identifying gap areas from literature study, hypothesis building	
II	**Research Design and Data Collection and Analysis:** Need of research design, concepts related to research design, different research designs, research plan, basic principles of experimental design and setup, collection of primary data, observation methods, interview methods, collection of data through questionnaire and schedules, collection of secondary data, selection of appropriate method for data collection, case study method, guidelines for developing questionnaire, successful interview, survey v/s experiment, processing and data analysis, use of statistical packages, measure of asymmetries and other measures. Fieldwork-The Nature of Field Work, Selection and Training of Investigators, Sampling Frame and Sample Selection, Field Operation, Field Administration.	12
III	**Probability Distribution and Hypothesis Testing:** Sampling and probability distribution, definitions and basic concepts of hypothesis testing, procedures of hypothesis testing, flow diagram for hypothesis testing, test of hypothesis, important parametric test, hypothesis testing of mean, proportion, tests for equality of mean and variances of two population, confidence interval, z-test, and X^2 test for goodness to fit, limitation of test of hypothesis.	12
IV	**Analysis of Variance and Covariance:** Basic principle of Analysis of Variance, ANOVA Technique, Setting up Analysis of Variance Table, short-cut method for one-way ANOVA, Coding method, Two-way ANOVA, ANOVA in Latin-square design, analysis of co-variance (ANCOVA), assumptions in ANCOVA. **Academic Ethics:** Plagiarism, exposure on anti-plagiarism tools.	12
V	**Technical Writing and IPR:** Academic writing, sources of information, assessment of quality of journals and articles, writing scientific report, structure and component of research report, types of report – technical reports and thesis, SCOPUS Index, citations, search engines beyond google, impact factor, H-Index. **IPR:** What is IPR?, importance of patents, types of IPR, process of patent.	12

References:

1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques,* New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nd.ed), Singapore, Pearson Education.
4. Neeraj Pandey, *Intellectual Property Rights* ,1st Edition, PHI
5. *Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley*
6. Goode W J &Hatt P K, Methods in social research, McGraw Hill
7. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)

Course Code	Course Name	Credits
PhdIT102	**Course suggested by Guide**	**04**
PhdIT103	**Course organized by Research Centre**	**04**

PhdIT102: Course suggested by Guide **Credits: 04**

This course is to be suggested by guide/supervisor in specific domain area of research undertaken by the research candidate.

Research candidates can undertake this course in consultation with guide/supervisor as per guidelines given below;

1. Relevant course shall be successfully completed at the *Ph.D research centre* which has 6 credits.

OR

1 MOOC course / NPTEL course / online courses from coursera, greatlearning, simplylearn etc. with the permission of guide / supervisor.

The guide is supposed to give 3 assignments based on the assigned course for internal evaluation purpose.

PhdIT103: Course organized by Research Centre **Credits: 04**

A training course will be organized by the research centre that will be based on the statistical tools and other technologies like R, Python, SPSS, MATLAB etc.

Description: This course intends to cover technological skills required for research. This knowledge will help them to implement their designed computational methods using some statistical package or programming language. They will also learn some advanced soft computing algorithms, networking architectures, cloud computing concepts, security algorithms etc. We also intend to introduce statistical concepts used to measure social and scientific phenomenon. The exercises will focus on use of statistical software packages such as R, Python, SPSS, STATA, and Social Network Analysis.

Course Code	Course Name	Credits
PhdIT104	**Seminar**	**04**

Following guidelines for credit seminar shall be followed:

1. The research scholar will have to present seminars on the topic to the guide.
2. Seminar should be based on thrust areas in specific research domain.
3. Research scholar should do literature survey, identify the topic for seminar and finalize the same in consultation with Guide/Supervisor.
4. Report should be compiled in the standard format as per University Guidelines for report writing and present in front of pair of Examiners appointed as per Vice Chancellor’s Directives.

Seminar should be assessed jointly by the pair of Internal and External Examiners

Following points must be assessed during the presentation of Credit Seminar

i. Quality of Literature survey and Novelty in the topic
ii. Relevance to the specialization
iii. Understanding of the topic
iv. Quality of Written and Oral Presentation

Program Structure B.E. Computer Engineering

Fourth Year (Computer) (Semester VII)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract**	**Tut**	**Theory**	**TW/ Pract**	**Tut**	**Total**
CPC701	Digital Signal Processing	4	2	-	4	1	-	5
CPC702	Cryptography and System Security	4	2	-	4	1	-	5
CPC703	Artificial Intelligence	4	2	-	4	1	-	5
CPE7042X	Elective-II	4	2	-	4	1	-	5
CPP701	Project I	-	-	-	-	3	-	3
CPL701	Network Threats and Attacks Laboratory	-	4	-	-	2	-	2
	Total	**16**	**12**	**-**	**16**	**09**	-	**25**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			**End Sem Exam**	**Exam Duration (in Hrs)**	**TW**	**oral**	**Tot**
		Test 1	**Test 2**	**Avg**					
CPC701	Digital Signal Processing	20	20	20	80	03	25	-	125
CPC702	Cryptography and System Security	20	20	20	80	03	25	25 (prac	150
CPC703	Artificial Intelligence	20	20	20	80	03	25	25	150
CPE7042X	Elective-II	20	20	20	80	03	25	25	150
CPP701	Project I	-	-	-	-	-	50	50	100
CPL701	Network Threats and Attacks Laboratory	-	-	-	-	-	25	50	50
	Total	**-**	**-**	**80**	**320**	-	**200**	**175**	**775**

Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester VIII)

(REV 201)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC801	Data Warehouse and Mining	4	2	-	4	1	-	5
CPC802	Human Machine Interaction	4	2	-	4	1	-	5
CPC803	Parallel and distributed Systems	4	2	-	4	1	-	5
CPE803X	Elective-III	4	2	-	4	1	-	5
CPP802	Project II	-	-	-	-	6	-	6
CPL801	Cloud Computing Laboratory	-	2	-	-	1	-	1
	Total	**16**	**10**	**-**	**16**	**11**	-	**27**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Tot
		Test 1	Test 2	Avg					
CPC801	Data Warehouse and Mining	20	20	20	80	03	25	25	150
CPC802	Human Machine Interaction	20	20	20	80	03	25	25	150
CPC803	Parallel and distributed Systems	20	20	20	80	03	25	25	150
CPE803X	Elective-III	20	20	20	80	03	25	25	150
CPP802	Project II	-	-	-	-	-	50	50	100
CPL801	Cloud Computing Laboratory	-	-	-	-	-	25	-	-
	Total			80	320		175	150	725

Elective I Sem 6

CPE6011	**Operation Research**
CPE6012	**Project Management**
CPE6013	**Foreigh Language – German**
CPE6014	**Foreigh Language – French**

Elective II Sem 7

System Group	**CPE7021**	Advance Algorithms
	CPE7022	Computer Simulation and Modeling
Electronics Group	**CPE7023**	Image Processing
Software Group	**CPE7024**	Software Architecture
	CPE7025	Soft Computing
DB Group	**CPE7026**	ERP and Supply Chain Management

Elective III - Sem 8

Electronics Group	**CPE8031**	Machine Learning
Digital Group	**CPE8032**	Embedded Systems
Network Group	**CPE8033**	Adhoc wireless networks
	CPE8034	Digital Forensic
DB Group	**CPE8035**	Big data Analytics

Course Code	Course/Subject Name	Credits
CPC701	**Digital Signal Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Signal Processing.
2. To explore the properties of DFT in mathematical problem solving.
3. To illustrate FFT calculations mathematically and develop FFT based DSP algorithms.
4. To introduce DSP processor for real time signal processing application

Outcomes: Learner will be able to…

1. To understand the concept of DT Signal and perform signal manipulation
2. To perform analysis of DT system in time domain
3. To develop FFT flow-graph and Fast DSP Algorithms.
4. To design DSP system for Real Time Signal Processing.

Module	Detailed Contents	Hrs.
01	**Discrete Time Signal** 1.1 Introduction to Digital Signal Processing, Discrete Time Signals, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations(shifting, addition, subtraction, multiplication), Classification of Signals, Linear Convolution formulation(without mathematical proof), Circular Convolution formulation(without mathematical proof), Matrix Representation of Circular Convolution, Linear by Circular Convolution. Auto and Cross Correlation formula evaluation,	12
02	**Discrete Time System** 2.1 Introduction to Discrete Time System, Classification of DT Systems (Linear/Non Linear, Causal/Non Causal, Time Invariant/Time Variant Systems, Stable/ Unstable), BIBO Time Domain Stability Criteria. LTI system, Concept of Impulse Response and Step Response. 2.2 Concept of IIR System and FIR System, Output of IIR and FIR DT system using Time Domain Linear Convolution formula Method.	08
03	**Discrete Fourier Transform** 3.1 Introduction to DTFT, DFT, Relation between DFT and DTFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. 3.2 Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT. Response of FIR system calculation in frequency domain using DFT.	08
04	**Fast Fourier Transform** 4.1 Radix-2 DIT-FFT algorithm, DIT-FFT Flowgraph for N=4, 6 & 8, Inverse	06

	FFT algorithm. Spectral Analysis using FFT, Comparison of complex and real, multiplication and additions of DFT and FFT.	
05	**DSP Algorithms** 5.1 Carls' Correlation Coefficient Algorithm, Fast Circular Convolution Algorithm, Fast Linear Convolution Algorithm, Linear FIR filtering using Fast Overlap Add Algorithm and Fast Overlap Save Algorithm,	08
06	**DSP Processors and Application of DSP** 6.1 Need for Special architecture of DSP processor, Difference between DSP processor & microprocessor, A general DSP processor TMS320C54XX series, Case study of Real Time DSP applications to Speech Signal Processing and Biomedical Signal Processing.	06

List of Experiments:

Implementation of programs must be either in C or C++ only. Application can be developed using open source simulation software such as Scilab. A List of compulsory eight experiments is given below. Additional experiments within the scope of the syllabus can be added.

1. Sampling and Reconstruction

Aim:
To study sampling and reconstruction of signal

Objective:
Develop a program to sample a continuous time signal and convert it to Discrete Time Signal.

Problem Definition:

1. Sample the input signal and display first 50 samples. Calculate data rate and bit rate.
2. Reconstruct the original signal and display the original and reconstructed signals.
3. Vary the sampling frequency and observe the change in the quality of reconstructed signal.

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2. To perform Discrete Correlation

Aim:
To study mathematical operation Correlation and measure degree of similarity between two signals

Objective:

1. Write a function to find correlation operation.
2. Calculate correlation of a DT signals and verify the results using mathematical formulation.
3. Measure the degree of similarity using Carl's Correlation Coefficient formula in time domain.

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find auto correlation of input signal. What is the significance of value of output signal value at n=0?.
2. Find auto correlation of delayed input signal.
3. Find cross correlation of input signal and delayed input signal,
4. Find cross correlation of input signal and scaled delayed input signal.
5. Compare the resultant signals. Give your conclusion.
6. Take two input finite length DT signals and develop a function to find Carl's Correlation Coefficient value. Determine the degree of similarity of two signals from the calculated Carl's Correlation Coefficient value.

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3. To perform Discrete Convolution

Aim:

The aim of this experiment is to study mathematical operation such as Linear convolution, Circular convolution, Linear convolution using circular convolution.

Objective:

1. Develop a function to find Linear Convolution and Circular Convolution
2. Calculate Linear Convolution, Circular Convolution, Linear Convolution using Circular Convolution and verify the results using mathematical formulation.
3. Conclude on aliasing effect in Circular convolution

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find Linear Convolution and Circular Convolution of L point sequence x[n] and M point sequence h[n].
2. Find Linear Convolution of L point sequence x[n] and M point sequence h[n] using Circular convolution.
3. Give your conclusion about No of values in linearly convolved signal, and Aliasing effect in Circular Convolution.

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4. To perform Discrete Fourier Transform

Aim:

The aim of this experiment is to study magnitude spectrum of the DT signal.

Objective:

1. Develop a function to perform DFT of N point signal
2. Calculate DFT of a DT signal and Plot spectrum of the signal.
3. Conclude the effect of zero padding on magnitude spectrum.
4. Calculate the number of real multiplications and real additions required to find DFT.

Input Specifications:

1. Length of Signal N
2. Signal values

Problem Definition:

1. Take any four-point sequence x[n].

- Find DFT X[k].
- Compute number of real multiplications and real additions required to find X[k].
- Plot Magnitude Spectrum of the signal.

2. Append the input sequence by four zeros. Find DFT and plot magnitude spectrum. Repeat the same by appending the sequence by eight zeros. Observe and compare the magnitude spectrum. Give your conclusion.

---

5. To perform Fast Fourier Transform

Aim:

To implement computationally fast algorithms.

Objective:

1. Develop a program to perform FFT of N point signal.
2. Calculate FFT of a given DT signal and verify the results using mathematical formulation.
3. Illustrate the computational efficiency of FFT.

Input Specifications:

- Length of Signal N
- Signal values

Problem Definition:

Take any eight-point sequence x[n].

- Find FFT X[k].
- Write number of real multiplications and real additions involved in finding X[k].

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6. Filtering of long Data Sequence

Aim:

To perform filtering of Long Data Sequence using Overlap Add Method and Overlap Save Method.

Objective:

Develop a function to implement Fast Overlap Add and Fast Overlap Save Algorithm using FFT.

Input Specifications:

1. Length of long data sequence and signal values.
2. Length of impulse response M and coefficient values of h[n].

Problem Definition:

Find the output of a Discrete Time system using Fast Overlap Add Method OR Fast Overlap Save Method.

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7. Real Time Signal Processing

Aim:

To perform real time signal processing using TMS320 Processor.

Objective:

Study real time signal processing.

Input Specifications:

1. Real Time Speech Signal

Problem Definition:

1) Capture the real time audio signal.
2) Filter it by convolving input signal with the impulse response of FIR filter using Fast Overlap Add filtering Algorithm OR Fast Overlao Save Filtering Algorithm.
3) Observe the quality of output signal.

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8. Application of Digital Signal Processing

Aim:

To implement any Signal Processing operation on one dimensional signal.

Objective:
To develop application of signal processing.

Input Specifications:
One dimensional signal.

Rules:

1. Number of students in one Group : min - 2 max -3
2. Decide one DSP application of your choice. Collect the information related to the application from the published granted patents. Download the related published papers from the standard refereed journals and conferences.
3. Develop a block diagram of the proposed system and flowchart of proposed system algorithm, implement it using Scilab/C, C++ language and obtain the appropriate results.
4. Prepare the three to four pages report on the mini project in IEEE paper format. Report should include Abstract, Introduction, Related Theory, Proposed System Design/Algorithm, Experimentation & Result Analysis, Conclusion, and References.
5.

Term Work:

- Term work shall consist of minimum **08** assignments and course project.
- Journal must include at least 1 assignment on each module and two quiz.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:……………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Text Books :

1. Ashok Ambardar, 'Digital Signal Processing', Cengage Learning, 2007,
   ISBN : 978-81-315-0179-5.

2. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education ISBN 0-201-59619- 9

3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, ‘Digital Signal Processing’ TataMcgraw Hill Publication First edition (2010). ISBN 978-0-07-066924-6.

4. Avtar Signh, S.Srinivasan,”Digital Signal Processing’, Thomson Brooks/Cole, ISBN : 981-243-254-4

Reference Books :

1. B. Venkatramani, M. Bhaskar ,”Digital Signal Processor’, TataMcGraw Hill, Second Edition, (2001). ISBN : 978-0-07-070256-1.

2. Sanjit Mitra, ‘Digital Signal Processing : A Computer Based Approach’ , TataMcGraw Hill, Third Edition

3. Dr, Shaila Apte, “Digital Signal Processing,”, Wiley India, Second Edition,2013 ISBN : 978-81-2652142-5

4. Proakis Manolakis, ‘Digital Signal Processing : Principles, Algorithms and Applications’ Fourth 2007, Pearson Education, ISBN 81-317-1000-9.

5. Monson H. Hayes, “Schaums Outline of Digital Signal Processing’ McGraw Hill International second edition. ISBN : 978-00-7163509-7

Course Code	Course/Subject Name	Credits
CPC702	**Cryptography and System Security**	5

Objectives:

1. To provide students with contemporary knowledge in Cryptography and Security.
2. To understand how crypto can be used as an effective tools in providing assurance concerning privacy and integrity of information.
3. To provide skills to design security protocols for recognize security problems.

Outcomes: Learner will be able to…

1. Understand the principles and practices of cryptographic techniques.
2. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for given application.
3. Appreciate the application of security techniques and technologies in solving real-life security problems in practical systems.
4. Apply appropriate security techniques to solve security problem
5. Design security protocols and methods to solve the specific security problems.
6. Familiar with current research issues and directions of security.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Security Attacks, Security Goals, Computer criminals, Methods of defense, Security Services, Security Mechanisms	06
02	**Basics of Cryptography** 2.1 Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties- Confusion, Diffusion, Block and Stream Ciphers.	06
03	**Secret Key Cryptography** 3.1 Data Encryption Standard(DES), Strength of DES, Block Cipher Design Principles and Modes of Operations, Triple DES, International Data Encryption algorithm, Blowfish, CAST-128.	06
04	**Public Key Cryptography** 4.1 Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange	04
05	**Cryptographic Hash Functions** 5.1 Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Authentication Protocols, Digital Signature Standards.	06
06	**Authentication Applications** 6.1 Kerberos, Key Management and Distribution, X.509 Directory Authentication service, Public Key Infrastructure, Electronic Mail Security: Pretty Good Privacy, S/MIME.	06

07	**7.1 Program Security** Secure programs, Nonmalicious Program Errors, Malicious Software – Types, Viruses, Virus Countermeasures, Worms, Targeted Malicious Code, Controls against Program Threats. **7.2 Operating System Security** Memory and Address protection, File Protection Mechanism, User Authentication. **7.3 Database Security** Security Requirement, Reliability and Integrity, Sensitive data, Inference, Multilevel Databases **7.4 IDS and Firewalls** Intruders, Intrusion Detection, Password Management, Firewalls-Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration, Trusted systems.	08
08	**8.1 IP Security** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining security Associations, Internet Key Exchange, Web Security: Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Electronic Payment. **8.2 Non-cryptographic protocol Vulnerabilities** DoS, DDoS, Session Hijacking and Spoofing, Software Vulnerabilities-Phishing, Buffer Overflow, Format String Attacks, SQL Injection.	06

Term Work:

Term work should consist of at least 10experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): …………..………..	(15)	Marks.
• Assignment:……………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Practical Exam will be based on above syllabus.

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. RSA and MD5 algorithms.
2. Packet Analyzer.

3. IPSec
4. Spoofing
5. PGP(Pretty Good Privacy)
6. Port Scanning
7. Vulnerability scanner
8. Buffer Overflow
9. Intrusion Detection System
10. Password cracking
11. Firewall
12. SSL

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Cryptography and Network Security: Principles and Practice 5th edition, William Stallings, Pearson.
2. Network Security and Cryptography 2nd edition, Bernard Menezes, Cengage Learning.
3. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

Reference Books:

1. Cryptography and Network Security by Behrouz A. Forouzan, TMH
2. Security in Computing by Charles P. Pfleeger, Pearson Education.
3. Computer Security Art and Science by Matt Bishop, Addison-Wesley.

Course Code	Course/Subject Name	Credits
CPC703	**Artificial Intelligence**	5

Objectives:

1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2. To make students understand and Explore the mechanism of mind that enable intelligent thought and action.
3. To make students understand advanced representation formalism and search techniques.
4. To make students understand how to deal with uncertain and incomplete information.

Outcomes: Learner will be able to

1. Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2. Ability to choose an appropriate problem solving method and knowledge representation technique.
3. Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4. Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5. Ability to design and develop the AI applications in real world scenario.

Module	Detailed Contents	Hrs
01	**Introduction to Artificial Intelligence** 1.1 Introduction , History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.	04
02	**Intelligent Agents** 2.1 Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	04
03	**Problem solving** 3.1 Solving problem by Searching : Problem Solving Agent, Formulating Problems, Example Problems. 3.2 Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS) , Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bounded heuristic Search. 3.3 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search,	14

	Genetic algorithms. 3.4 Adversarial Search: Games, Optimal strategies, The minimax algorithm , Alpha-Beta Pruning.	
04	**Knowledge and Reasoning** 4.1 Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining. 4.2 Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG). 4.3 **Uncertain Knowledge and Reasoning:** Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	12
05	**Planning and Learning** 5.1The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. 5.2 Learning: Forms of Learning, Inductive Learning, Learning Decision Tree. 5.3 Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	10
06	**Applications** 6.1 Natural Language Processing(NLP), Expert Systems.	04

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/case studies): …………..	(15)	Marks.
• Assignment:………..…………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

There will be at least two assignments covering the above syllabus.

Practical/Oral examination:

Practical examination based on the above syllabus will be conducted.

List of AI Practical / Experiments

All the programs should be implemented in C/C++/Java/Prolog under Windows or Linux environment. Experiments can also be conducted using available open source tools.

1. One case study on NLP/Expert system based papers published in IEEE/ACM/Springer or any prominent journal.

2. Program on uninformed and informed search methods.

3. Program on Local Search Algorithm.

4. Program on Optimization problem.

5. Program on adversarial search.

6. Program on Wumpus world.

7. Program on unification.

8. Program on Decision Tree.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (Practicals):

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight "Artificial Intelligence "Third Edition
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach “Second Edition" Pearson Education.
2. Saroj Kaushik “Artificial Intelligence” , Cengage Learning.
3. George F Luger “Artificial Intelligence” Low Price Edition , Pearson Education., Fourth edition.

Reference Books:

1. Ivan Bratko “PROLOG Programming for Artificial Intelligence”, Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight “Artificial Intelligence” Third Edition
3. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, “Neural Network Design” CENGAGE Learning, India Edition.
5. Patrick Henry Winston , “Artificial Intelligence”, Addison-Wesley, Third Edition.
6. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.
7. N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.

Course Code	Course/Subject Name	Credits
CPE7021	**Advanced Algorithms**	5

Objectives:

1. To teach fundamentals of analysis of algorithm at depth
2. To provide in depth study of advanced data structures and its uses
3. To teach analysis of problems from different domains

Outcomes: Learner will be able to…

1. Identify and use suitable data structures for given problem from different domains
2. Appreciate the role of Graph algorithms in solving variety of problems
3. Appreciate the role of Optimization by using linear programing
4. Analyze the various algorithms from different domains

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Asymptotic notations Big O, Big Θ,Big Ω,o ,ω notations ,Proofs of master theorem, applying theorem to solve problems	03
02	**Advanced Data Structures** 2.1 Red-Black Trees: properties of red-black trees , Insertions , Deletions 2.2 B-Trees and its operations 2.3 Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps	09
03	**Dynamic Programing** 3.1 matrix chain multiplication, cutting rod problem and its analysis	06
04	**Graph algorithms** 4.1 Bellman ford algorithm, Dijkstra algorithm, Johnson's All pair shortest path algorithm for sparse graphs	06
05	**Maximum Flow** 5.1 Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08
06	**Linear Programing** 6.1 Standard and slack forms, Formulating problems as linear programs, simplex algorithm, Duality, Initial basic feasible solution	08
07	**Computational Ggeometry** 7.1 Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08

Term Work:

Term work should consist of at least 6 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): …………..……….. (15) Marks.
- Assignment:………………………………….……. (05) Marks.
- Attendance (Theory+ Practical)……………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral examination based on above syllabus will be conducted

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Red – black trees and its various operations
2. Binomial Heaps and its various operations
3. Dynamic programing: matrix chain multiplication , cutting rod example
4. Bellman ford , Johnson's algorithm for sparse graphs
5. Ford Fulkerson algorithm , push relabel to front methods
6. Finding closest pair of points, Determining the convex hull
7. Implementation of Simplex algorithm

Text Books:

1. T.H. Coreman , C.E. Leiserson, R.L. Rivest, and C. Stein, "Introduction to algorithms",2nd edition , PHI publication 2005
2. Ellis Horowitz , Sartaj Sahni , S. Rajsekaran. "Fundamentals of computer algorithms" University press

Course Code	Course/Subject Name	Credits
CPE7023	**Image Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Image Processing and Video Processing .
2. To understand basic image enhancement and segmentation techniques.
3. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
4. To learn Image Compression and Decompression Techniques

Outcomes: Learner will be able to…

1. Understand the concept of Digital Image and Video Image.
2. Explain image enhancement and Segmentation technique.
3. Develop fast image transform flowgraph
4. Solve Image compression and decompression techniques
5. Perform Binary Image Processing Operations

Module	Detailed Contents	Hrs.
01	**Digital Image and Video Fundamentals** 1.1 Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization, Representation of Digital Image, Connectivity, Image File Formats : BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV) Introduction to Digital Video, Chroma Sub-sampling, CCIR standards for Digital Video	06
02	**Image Enhancement** 2.1 Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Neighbourhood Processing, Spatial Filtering, Smoothing and Sharpening Filters. Homomorphic Filtering	09
03	**Image Segmentation and Representation** 3.1 Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Moments.	09
04	**Image Transform** 4.1 Introduction to Unitary Transform, Discrete Fourier Transform(DFT), Properties of DFT, Fast Fourier Transform(FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	09
05	**Image Compression** 5.1 Introduction, Redundancy, Fidelity Criteria, 5.2 Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	09

	5.3 Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	
06	**Binary Image Processing** 6.1 Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm	06

Term Work:

Term work should consist of at least 08 experiments.
Journal must include at least 1 assignment on each module and two quiz.
The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:…………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral exam will be based on the above syllabus

Practicals

Implementation of programs must be either in C or C++ only. A List of experiments is given below. Input can be Monochrome OR Colour Image. Additional experiments within the scope of the syllabus can be added.

1. Image Enhancement [Any two techniques]
   (1) using Zero Memory Point Operations.
   (2) using Histogram Processing Technique
   (3) using Spatial Filtering [Smoothing Filters/ Sharpening Filters]
   (4) using Homomorphic Filtering

2. Image Segmentation [Any two techniques]
(1) Horizontal and Vertical Line Detection
(2) Edge Detection
(3) Split and Merge Technique
(4) Edge Linking using Hough Transform

3. Image Compression and De-compression [Any two techniques]
(1) Arithmetic Coding and Decoding
(2) Huffman Coding and Decoding
(3) IGS Quantization/ Vector Quantization based Compression and De-compression
(4) Transform based Image Compression and De-compression [FFT/ FHT/DCT/ DWT]

4. Binary Image Processing [Any two techniques]
    (1) Opening followed by Closing
    (2) Hit or Miss Transform
    (3) Thinning/Thickening/ Region Fillling / Boundary Extraction
    (4) Connected Component Algorithm

Text Books :

1. Rafel C. Gonzalez and Richard E. Woods, ‘Digital Image Processing’, Pearson Education Asia, Third Edition, 2009,

2. S. Jayaraman, E.Esakkirajan and T.Veerkumar, “Digital Image Processing” TataMcGraw Hill Education Private Ltd, 2009,

3. Anil K. Jain, “Fundamentals and Digital Image Processing”, Prentice Hall of India Private Ltd, Third Edition

4. S. Sridhar, “Digital Image Processing”, Oxford University Press, Second Edition, 2012.

5. Robert Haralick and Linda Shapiro, “Computer and Robot Vision”, Vol I, II, Addison Wesley, 1993.

Reference Books:

1. Dwayne Phillps, “Image Processing in C”, BPB Publication, 2006

2. B. Chandra and D.Dutta Majumder, “Digital Image Processing and Analysis”, Prentice Hall of India Private Ltd, 2011

3. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, Prentice Hall of India Private Ltd, Third Edition

4. Fred Halshall, “Multimedia Communications: Applications, Networks Protocols and Standards,”, Pearson Education 2001

5. David A. Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, Pearson Education, Limited, 2011

Course Code	Course/Subject Name	Credits
CPE7024	**Software Architecture**	5

Outcomes:

Software architecture is foundational to the development of large, practical software-intensive applications.

After successful completion of this course learner will be able to:

- Visualize the architectural concepts in development of large, practical software-intensive applications.
- Rather than focusing on one method, notation, tool, or process, this new course widely surveys software architecture techniques, enabling us to choose the right tool for the job at hand.

Module	Detailed Contents	Hrs.
01	**Basic Concepts** 1.1 Concepts of Software Architecture 1.2 Models. 1.3 Processes. 1.4 Stakeholders	03
02	**Designing Architectures** 2.1 The Design Process. 2.2 Architectural Conception. 2.3 Refined Experience in Action: Styles and Architectural Patterns. 2.4 Architectural Conception in Absence of Experience.	02
03	**Connectors** 3.1 Connectors in Action: A Motivating Example. 3.2 Connector Foundations. 3.3 Connector Roles. 3.4 Connector Types and Their Variation Dimensions. 3.5 Example Connectors.	06
04	**Modeling** 4.1 Modeling Concepts. 4.2 Ambiguity, Accuracy, and Precision. 4.3 Complex Modeling: Mixed Content and Multiple Views. 4.4 Evaluating Modeling Techniques. 4.5 Specific Modeling Techniques.	04
05	**Analysis** 5.1 Analysis Goals. 5.2 Scope of Analysis. 5.3 Architectural Concern being Analyzed. 5.4 Level of Formality of Architectural Models.	08

	5.5 Type of Analysis. 5.6 Analysis Techniques.	
06	**Implementation and Deployment** 6.1 Concepts. 6.2 Existing Frameworks. 6.3 Software Architecture and Deployment. 6.4 Software Architecture and Mobility.	04
07	**Conventional Architectural styles** 7.1 Pipes and Filters 7.2 Event- based, Implicit Invocation 7.3 Layered systems 7.4 Repositories 7.5 Interpreters 7.6 Process control	05
08	**Applied Architectures and Styles** 8.1 Distributed and Networked Architectures. 8.2 Architectures for Network-Based Applications. 8.3 Decentralized Architectures. 8.4 Service-Oriented Architectures and Web Services.	08
09	**Designing for Non-Functional Properties** 9.1 Efficiency. 9.2 Complexity. 9.3 Scalability and Heterogeneity. 9.4 Adaptability. 9.5 Dependability.	04
10	**Domain-Specific Software Engineering** 10.1 Domain-Specific Software Engineering in a Nutshell. 10.2 Domain-Specific Software Architecture. 10.3 DSSAs, Product Lines, and Architectural Styles.	04

Term Work:

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments):…………………….. (20) Marks.
- Attendence:…….……………………………………… (05) Marks.

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

An Oral examination is to be conducted based on the above syllabus

Topics For Experiment:

1. Modeling using xADL
2. Analysis - Case study
3. Visualization using xADL 2.0
4. Integrate software components using a middleware
5. Use middleware to implement connectors
6. Wrapper to connect two applications with different architectures
7. Creating web service
8. Architecture for any specific domain

Books:

Text Books:

1. “Software Architecture: Foundations, Theory, and Practice” by Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, ISBN: 978-0-470-16774-8
2. M. Shaw: Software Architecture Perspectives on an Emerging Discipline, Prentice-Hall.
3. Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice, Pearson.

References:

1. “Pattern Oriented Software Architecture” by Frank Buchnan et al, Wiley India.
2. “The Art of Software Architecture” by Stephen T. Albin.

Course Code	Course/Subject Name	Credits
CPE7025	**Soft Computing**	5

Objectives:

1. To Conceptualize the working of human brain using ANN.
2. To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
3. To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
4. To provide the mathematical background for carrying out the optimization and familiarizing genetic algorithm for seeking global optimum in self-learning situation.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use fuzzy logic.
2. Ability to design inference systems.
3. Ability to understand the difference between learning and programming and explore practical applications of Neural Networks (NN).
4. Ability to appreciate the importance of optimizations and its use in computer engineering fields and other domains.
5. Students would understand the efficiency of a hybrid system and how Neural Network and fuzzy logic can be hybridized to form a Neuro-fuzzy network and its various applications.

Module	Detailed Contents	Hours
01	**Introduction to Soft Computing** 1.1 Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	**04**
02	**Neural Networks** **2.1 Basics of Neural Networks:** Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model, **2.2 Supervised Learning algorithms:** Perceptron (Single Layer, Multi layer), Linear separability, Delta learning rule, Back Propagation algorithm, **2.3 Un-Supervised Learning algorithms:** Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	**14**

03	**Fuzzy Set Theory** 3.1 Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of membership function, Fuzzy extension principle, Fuzzy Systems- fuzzification, defuzzification and fuzzy controllers.	**14**
04	**Hybrid system** 4.1 Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System(ANFIS).	**04**
05	**Introduction to Optimization Techniques** **5.1 Derivative based optimization-** Steepest Descent, Newton method. **5.2 Derivative free optimization-** Introduction to Evolutionary Concepts.	**06**
06	**Genetic Algorithms and its applications:** 6.1 Inheritance Operators, Cross over types, inversion and Deletion, Mutation Operator, Bit-wise Operators, Convergence of GA, Applications of GA.	**06**

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/case studies): …………..	(15)	Marks.
• Assignments:…………………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral examination will be based on the above syllabus.

PRACTICALS:

All the programs should be implemented in C/C++/Java/MATLAB under Windows or Linux environment. Experiments can also be conducted using available open source tools like OCTAVE and SCILAB

LIST OF SC PRACTICAL / EXPERIMENTS

1. One case study on Fuzzy/Neural/GA based papers published in IEEE/ACM/Springer or any prominent journal.

2. To implement Fuzzy Sets.

3. To implement Fuzzy Relations.

4. To implement Fuzzy Controllers.

5. To implement Basic Neural Network learning rules.

6. To implement any Supervised Learning algorithm.

7. To implement any Unsupervised Learning algorithm.

8. To implement a simple application using Genetic Algorithm.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (for practicals) :

1. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
2. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
3. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.

4. Satish Kumar, “Neural Networks –A classroom approach”, Second Edition,TMH Publication.

Text Books:

1. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.
2. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
3. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
4. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
5. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

Reference Books:

1. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
2. Zimmermann H.S "Fuzzy Set Theory and its Applications" Kluwer Academic Publishers.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.

Course Code	Course/Subject Name	Credits
CPE7026	**Enterprise Resource Planning and Supply Chain Management (ERP & SCM)**	5

Objectives:

1. To understand the technical aspects of ERP and SCM systems.
2. To understand the steps and activities in the ERP and SCM life cycle.
3. To identify and describe typical functionality in an ERP and SCM system.
4. To understand tools and methodology used for designing ERP and SCM for an Enterprise.

Outcomes: Learner will be able to…

1. To conceptualize the basic structure of ERP and SCM
2. To identify implementation strategy used for ERP and SCM.
3. To apply design principles for various business module in ERP and SCM.
4. To apply different emerging technologies for implementation of ERP and SCM.

Module	**Detailed Contents**	**Hours**
Enterprise Resource Planning		
01	**Introduction** 1.1 What is an Enterprize, Introduction to ERP, Need for ERP, Structure of ERP, Scope and Benefits, Typical business processes.	02
02	**ERP and Technology** 2.1 ERP and related technologies, Business Intelligence, E-business and E-commerce, Business Process Reengineering,	04
03	**ERP and Implementation** 3.1 ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition , implementation methodology.	06
04	**ERP Business Modules** 4.1 Modules: Finance, manufacturing, human resources, quality management, material management, marketing. Sales distribution and service.	08
05	**Extended ERP** 5.1 Enterprise application Integration (EAI), open source ERP, cloud ERP.	04
Supply Chain Management (SCM)		
06	**Introduction and strategic decisions in SCM**	08

	6.1 Introduction to SCM, Generic Types of supply chain, Major Drivers of Supply chain, Strategic decisions in SCM, Business Strategy, CRM strategy, SRM strategy, SCOR model.	
07	**Information Technology in SCM** 7.1 Types of IT Solutions like Electronic Data Inter change (EDI), Intranet/ Extranet, Data Mining/ Data Warehousing and Data Marts, E-Commerce, E- Procurement, Bar coding, RFID, QR code.	06
08	**Mathematical modelling for SCM** 8.1 Introduction, Considerations in modelling SCM systems, Structuring the logistics chain, overview of models: models on transportation problem, assignment problem, vehicle routing problem, Model for vendor analysis, Make versus buy model.	06
09	**Agile Supply Chain** 9.1 Introduction, Characteristics of Agile Supply Chain, Achieving Agility in Supply Chain.	02
10	**Cases of Supply Chain** 10.1 Cases of Supply Chain like, News Paper Supply Chain, Book Publishing, Mumbai Dabbawala, Disaster management, Organic Food, Fast Food.	02

Term Work:

The distribution of marks for term work shall be as follows:

• Mini project:…………………………………….…………	(20)	Marks.
• Attendance ………………………...…………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral examination will be based on the above syllabus.

The lab will be conducted on mini project which may be conducted on the following:

1) Simulating business processes of an Enterprise.
2) Designing a web portal for an Enterprise using E-business Models.
3) E-procurement model.
4) Open source ERP
5) Cloud ERP
6) Business process agility
7) SCM model.
8) Implementing Business Intelligence
9) Any other relevant topics covering the syllabus.

Text Books:

1. Enterprise Resource Planning : concepts & practices, by V.K. Garg & N.K. Venkatakrishnan ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. ERP Demystified: II Edition, by Alexis Leon,McGraw Hill .
4. Enterprise wide resource planning: Theory & practice: by Rahul Altekar,PHI.

Reference Books:

1. ERP to E^2 ERP: A Case study approach, by Sandeep Desai, Abhishek Srivastava, PHI.

2. Managerial Issues of ERP system, by David Olson, McGraw Hill.

Course Code	Course/Subject Name	Credits
CPE7022	**Computer Simulation and Modeling**	5

Course Objectives:

This course presents an introduction to discrete event simulation systems. Emphasis of the course will be on modeling and the use of simulation languages/software to solve real world problems in the manufacturing as well as services sectors. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly. The "theory" of simulation involves probability and statistics, thus a good background in probability and statistics is a required prerequisite

Course Outcomes:

1. Apply simulation concepts to achieve in business, science, engineering, industry and services goals
2. Demonstrate formulation and modeling skills.
3. Perform a simulation using spreadsheets as well as simulation language/package
4. Generate pseudorandom numbers using the Linear Congruential Method
5. Evaluate the quality of a pseudorandom number generator using statistical tests
6. Analyze and fit the collected data to different distributions

Module	Detailed Contents	Hours
	Computer Simulation and Modeling	
01	Introduction to Simulation. Simulation Examples. General Principles	15
02	Statistical Models in simulation. Queuing Models	08
03	Random Number Generation. Testing random numbers (Refer to Third edition) Random Variate Generation: Inverse transform technique, Direct Transformation for the Normal Distribution, Convolution Method, Acceptance-Rejection Technique (only Poisson Distribution).	09

04	Analysis of simulation data : Input Modeling ,Verification, Calibration and Validation of Simulation , Models , Estimation of absolute performance.	12
05	Application : Case study on 1. Processor and Memory simulation 2. Manufacturing & Material handling	04

Text Books:

Discrete Event System Simulation; Third Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

Discrete Event System Simulation; Fifth Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

References:

4. System Modeling & Analysis; Averill M Law, 4th Edition TMH.
5. Principles of Modeling and Simulation; Banks C M , Sokolowski J A; Wiley
6. System Simulation ; Geoffrey Gordon ; EEE
7. System Simulation with Digital Computer; Narsing Deo, PHI

Term work:

Laboratory work: 10 marks

Mini Simulation Project presentation: 10 marks

Attendance : 5 marks

Suggested Practical List (If Any):

Perform simulation exercises given in the text book (third edition) using spreadsheets and/or simulation language/package

5. Queue- single server, multi-server, classic case- dump truck
6. Inventory – Lead time=0, lead time fixed, lead time probabilistic
7. Reliability problem
8. Tutorials on statistical models
9. Random number generate and test
10. Goodness of fit test
11. Output analysis – Point estimate and Confidence Interval

Simulation: Real World Examples – can be in the field of business, transportation, medical, computing, manufacturing and material handling- Presentation to be taken.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Course Code	Course/Subject Name	Credits
CPL701	**Network threats and attacks Laboratory**	02

Outcomes: After completion of this Laboratory course learner will be able To

1. Use network-based tools for network analysis
2. Use techniques for Network scaning
3. Identify network vulnerability
4. Use tools to simulate intrusion detection system
5. To understand and install a firewall

Module	Detailed Contents
01	**1.1 Title:** Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars. **Objective:** Objective of this module to how to gather information about the networks by using different n/w reconnaissance tools. **Scope:** Network analysis using network based tools **Technology**: Networking
02	**2.1 Title:** Study of packet sniffer tools like wireshark, ethereal, tcpdump etc. You should be able to use the tools to do the following 1. Observer performance in promiscuous as well as non-promiscous mode. 2. Show that packets can be traced based on different filters. **Objective:** Objective of this module is to observer the performanance in promiscuous & non-promiscous mode & to find the packets based on different filters. **Scope:** Packet grapping, message and protocol analysis **Technology:** Networking
03	**3.1 Title:** Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc. **Objective:** objective of this module to learn nmap installation & use this to scan different ports. **Scope:** used for ip spoofing and port scanning **Technology**: Networking

04	**4.1 Title:** Detect ARP spoofing using open source tool ARPWATCH. **Objective:** Objective of the module to find ARP spoofing using open source. **Scope**: Ip spoofing using arp packaging tool **Technology:** Networking
05	**5.1 Title:** Use the Nessus tool to scan the network for vulnerabilities. **Objective:** Objective of the module is scan system and network analysis. **Scope:** It used for system analysis, security and process analysis **Technology:** Networking
06	**6.1 Title:** Implement a code to simulate buffer overflow attack. **Objective:** Objective of the module Is to check buffer overflow in an NS2 environment **Scope:** It uses to analyse memory overflow attack **Technology**: Networking
07	**7.1 Title:** Set up IPSEC under LINUX **Objective:** Objective of the module for implementing security vulnerabilities **Scope:** to study different ipsec tools. **Technology**: Networking
08	**8.1 Title:** Install IDS (e.g. SNORT) and study the logs. **Objective:** Simulate intrusion detection system using tools such as snort **Scope:** It is used for intrusion detection system vulnerability scans **Technology:** Networking
09	**9.1 Title:** Use of iptables in linux to create firewalls. **Objective:** To study how to create and destroy firewall security parameters. **Scope:** system security and network security **Technology**: Networking
10	**10.1 Title:** Mini project **Objective:** To implement Networking concepts

	Scope: To understand Network & system tools **Technology:** Networking

Term Work:

The distribution of marks for term work shall be as follows:

• Lab Assignments:..	(10)	
• Mini project:……………………………….…………	(10)	Marks.
• Attendance ………………………...…………….	(05)	Marks
TOTAL: ………………………………………………….	**(25)**	**Marks.**

Oral examination:

Oral examination is to be conducted by pair of internal and external examiners based on above syllabus and the mini projects done.

References:

1. Network Security Assessment by Chris McNab, O'Reilly
2. Network Security Hacks, Andrew Lockhart, O'Reilly
3. The Web Application Hacker's Handbook 2nd Edition by Dafydd Stuttard & Marcus Pinto,Wiley Publication(2014).
4. Securing the Virtual Environment by Davi Ottenheimer & Matthew Wallace,Willey Publication(2012).

Course Code	Course/Subject Name	Credits
CPC801	**Data Warehousing and Mining**	5

Objectives:

1. To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

Outcomes: Learner will be able to…

1. Enable students to understand and implement classical algorithms in data mining and data warehousing; students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
2. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.

Module	**Detailed Contents**	**Hrs.**
01	**Introduction to Data Warehousing** 1.1 The Need for Data Warehousing; Increasing Demand for Strategic Information; Inability of Past Decision Support System; Operational V/s Decisional Support System; Data Warehouse Defined; Benefits of Data Warehousing ;Features of a Data Warehouse; The Information Flow Mechanism; Role of Metadata; Classification of Metadata; Data Warehouse Architecture; Different Types of Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies.	04
02	**Dimensional Modeling** 2.1 Data Warehouse Modeling Vs Operational Database Modeling; Dimensional Model Vs ER Model; Features of a Good Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; The Factless Fact Table; Updates To Dimension Tables: Slowly Changing Dimensions, Type 1 Changes, Type 2 Changes, Type 3 Changes, Large Dimension Tables, Rapidly Changing or Large Slowly Changing Dimensions, Junk Dimensions, Keys in the Data Warehouse Schema, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star.	06
03	**ETL Process** 3.1 Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Extracting Data: Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Data Loading: Techniques of Data Loading, Loading the Fact Tables and Dimension Tables Data Quality; Issues in Data Cleansing.	06
04	**Online Analytical Processing (OLAP)**	04

	4.1 Need for Online Analytical Processing; OLTP V/s OLAP; OLAP and Multidimensional Analysis; Hypercubes; OLAP Operations in Multidimensional Data Model; OLAP Models: MOLAP, ROLAP, HOLAP, DOLAP;	
05	**Introduction to data mining** 5.1 What is Data Mining; Knowledge Discovery in Database (KDD), What can be Data to be Mined, Related Concept to Data Mining, Data Mining Technique, Application and Issues in Data Mining	02
06	**Data Exploration** 6.1 Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.	02
07	**Data Preprocessing** 7.1 Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	04
08	**Classification** 8.1 Basic Concepts; **Classification methods:** 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes’ Classifier. **8.2 Prediction**: Structure of regression models; Simple linear regression, Multiple linear regression. **8.3 Model Evaluation & Selection: A**ccuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap; Comparing Classifier performance using ROC Curves. **8.4 Combining Classifiers**: Bagging, Boosting, Random Forests.	06
09	**Clustering** 9.1 What is clustering? Types of data, Partitioning Methods (K-Means, K-Medoids) Hierarchical Methods(Agglomerative , Divisive, BRICH), Density-Based Methods (DBSCAN, OPTICS)	06
10	**Mining Frequent Pattern and Association Rule** 10.1 Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Mining closed and maximal patterns; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, Pattern Evaluation Measures; Introduction to Constraint-Based Association Mining.	08

Term Work:

Term work should consist of at least of the following:

1. One case study given to a group of 3 /4 students of a data mart/ data warehouse.
    a. Write Detail Statement Problem and creation of dimensional modeling (creation star and snowflake schema)
    b. Implementation of all dimension table and fact table
    c. Implementation of OLAP operations.
2. Implementation of classifier like Decision tree, Naïve Bayes, Random Forest using any languages like Java
3. Use WEKA to implement like Decision tree, Naïve Bayes, Random Forest
4. Implementation of clustering algorithm like K-means, K- Medoids, Agglomerative, Divisive using languages any like Java, C# , etc.
5. Use WEKA to implement the following Clustering Algorithms – K-means, Agglomerative, Divisive.
6. Implementation Association Mining like Apriori, FPM using languages like Java, C#, etc.
7. Use WEKA to implement Association Mining like Apriori, FPM.
8. Use R tool to implement Clustering/Association Rule/ Classification Algorithms.
9. Detailed study of any one BI tool like Oracle BI, SPSS, Clementine, and XLMiner etc. (paper Assignment)

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

An oral exam will be held based on the above syllabus

Text Books:

1) Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition

2) Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India
3) Reema Theraja “Data warehousing”, Oxford University Press.
4) M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education

Reference Books:

1) Randall Matignon, "Data Mining using SAS enterprise miner ", Wiley Student edition.
2) Alex Berson , S. J. Smith, “Data Warehousing, Data Mining & OLAP” , McGraw Hill.
3) Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4) Daniel Larose, “Data Mining Methods and Models”, Wiley India.

Course Code	Course/Subject Name	Credits
CPC802	**Human Machine Interaction**	5

Objectives:

1. To stress the importance of a good interface design.
2. To understand the importance of human psychology in designing good interfaces.
3. To motivate students to apply HMI in their day – to – day activities.
4. To bring out the creativity in each student – build innovative applications that are user friendly.
5. To encourage students to indulge into research in Machine Interface Design.

Outcomes: Learner will be able to…

1. To design user centric interfaces.
2. To design innovative and user friendly interfaces.
3. To apply HMI in their day-to-day activities.
4. To criticise existing interface designs, and improve them.
5. To Design application for social and technical task.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields. 1.2 The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error;	10
02	**Understanding goal directed design** 2.1 Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels; Understanding users; Modeling users – personas and goals.	08
03	**GUI** 3.1 benefits of a good UI; popularity of graphics; concept of direct manipulation; advantages and disadvantages; characteristics of GUI; characteristics of Web UI; General design principles.	08
04	**Design guidelines** 4.1 perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.	08
05	**Interaction styles** 5.1 menus; windows; device based controls, screen based controls;.	06
06	**Communication** 6.1 text messages; feedback and guidance; graphics, icons and images; colours.	08

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/case studies): …………..	(15)	Marks.
• Assignment:…….………………………………………	(05)	Marks.
• Attendance …………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Laboratory:

Students are free to choose any tool that they feel appropriate for a given experiment. Each experiment will involve research about a certain category of people, and then developing an appropriate interface.

Students are expected to perform at least eight experiments from the given list.

LIST OF HMI PRACTICAL / EXPERIMENTS

1. Know your client –

    a. Children (4-5 years of age): An application to teach math.

    b. Teenagers: Design a digital diary for young teens to help them overcome various social pressures they deal with during their teen years. The diary should also be like a self help tool which would help them deal with incidents like bullying, peer pressure, etc.. This is an open project and you can think in any direction to make the children sail through their teen years while trying to discover life around them.

    c. Older generation: Folks from the older generation has been very wary of using their credit card on the Internet. They have various concerns when it comes to paying their bills. Also because of their old age, it will be beneficial for them to use the internet and pay their phone, electricity, gas, etc. bills

    d. Rural people: ATVM for train ticketing in rural area

2. Understand the trouble of interacting with machines - Redesign interfaces of home appliances like microwave oven, land-line phone, fully automatic washing machine.

3. Learn HCI design principles – heuristic evaluation: Identify 5 different websites catering to one specific goal (eg. Goal – on-line shopping and 5 different websites – ebay, amazon, flipkart, zovi, myntra) and perform a competitive analysis on them to understand how each one caters to the goal, the interactions and flow of the payment system and prepare a report on the same..

4. Learn the importance of menus and navigation – website redesign: News websites like CNN are always cluttered with information. It takes the user a few minutes to find his way through and maybe more minutes to look for some specific information. Redesign the news websites to make it look less cluttered, provide relevant information (a person sitting in Russia should not get US news as top news), intelligently dig information that he might be interested in based on his searches on the web.

5. Learn the importance of connecting humans – service design : How often have you found yourself waiting at the airport for a flight that is delayed or you've missed it and the next one is 4 hours from now, or waiting for a connecting flight? Design an experience for passengers to deal with the long waiting hours.

6. Learn the use of statistical graphics – expense tracker: Matt is a young engineer who just finished his summer internship at a leading Software Company in the United States. He has never been independent in handling his own finances and after this internship his father has asked him to start managing his money on his own. He is looking for a tool/app/software that would help him budget his finances, create goals and track them, categorize and track his credit card spending and also get insights on the various types of categories he's spending on. Design a tool/app/software that would help Matt manage his personal finances given the above requirement.

7. Learn the importance of graphics – way finding: Design a map for someone who is new to the city/town/village and is trying to understand how to commute from one place to another (inspired by New York Subway Maps, London Subway Maps)

8. Icon designing: Choose a unique domain, design a few icons and show how it can be accommodated on an interface.

9. Understand the need of colors and animation – web site for an artist: A celebrity in some form of art like music, dance, painting, martial arts, etc (not actors). This site will be used to display his works and should portray his character.

10. Understand the various input methods available for interaction – concept generation: Study the various technologies for typing – standard keyboards QWERTY, T9 (predictive text), multi-touch (SYWPE, etc.), gestures and brainstorm on the various ways in which you could improve one of the existing technologies. You could choose any of the different input types.

11. Any other new relevant topics covering the above syllabus.

Text Books:

1. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale “Human Computer Interaction”, Prentice Hall.
2. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
5. Donald A. Normann, “Design of everyday things”, Basic Books; Reprint edition 2002.

Reference Books:

1. Donald A. Norman, “The design of everyday things”, Basic books.
2. Rogers Sharp Preece, “Interaction Design:Beyond Human Computer Interaction”, Wiley.
3. Guy A. Boy “The Handbook of Human Machine Interaction”, Ashgate publishing Ltd.

Course Code	Course/Subject Name	Credits
CPC803	**Parallel and Distributed Systems**	5

Objectives:

1. To provide students with contemporary knowledge in parallel and distributed systems
2. To equip students with skills to analyze and design parallel and distributed applications.
3. To provide master skills to measure the performance of parallel and distributed algorithms

Outcomes: Learner will be able to…

1. Apply the principles and concept in analyzing and designing the parallel and distributed system
2. Reason about ways to parallelize problems.
3. Gain an appreciation on the challenges and opportunities faced by parallel and distributed systems.
4. Understand the middleware technologies that support distributed applications such as RPC, RMI and object based middleware.
5. Improve the performance and reliability of distributed and parallel programs.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Parallel Computing, Parallel Architecture, Architectural Classification Scheme, Performance of Parallel Computers, Performance Metrics for Processors, Parallel Programming Models, Parallel Algorithms.	06
02	**Pipeline Processing** 2.1 Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline Stage Design, Hazards, Dynamic Instruction Scheduling,	06
03	**Synchronous Parallel Processing** 3.1 Introduction, Example-SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and memory in array processors, Case studies of SIMD parallel Processors	06
04	**Introduction to Distributed Systems** 4.1 Definition, Issues, Goals, Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept, Models of Middleware, Services offered by middleware, Client Server model.	06
05	**Communication** 5.1 Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication	04
06	**Resource and Process Management** 6.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration	06
07	**Synchronization**	08

	7.1 Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure, Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm 7.2 Token Based Algorithms: Suzuki-Kasami's Broardcast Algorithms, Singhal's Heurastic Algorithm, Raymond's Tree based Algorithm, Comparative Performance Analysis.	
08	**Consistency and Replication** 8.1 Introduction, Data-Centric and Client-Centric Consistency Models, Replica Management. **Distributed File Systems** 8.2 Introduction, good features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Network File System(NFS), Andrew File System(AFS), Hadoop Distributed File System and Map Reduce.	06

Term Work:

Term work should consist of at least 10 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………………………..	(15)	Marks.
• Assignments: ……………………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral Examination will be based on above syllabus

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Load Balancing Algorithm.
2. Scalability in Distributed Environment
3. Client/server using RPC/RMI.
4. Inter-process communication
5. Election Algorithm.
6. Distributed Deadlock.
7. Name Resolution protocol.
8. Clock Synchronization algorithms.
9. Mutual Exclusion Algorithm.
10. Group Communication.
11. CORBA architecture.
12. Parallel Algorithms.
13. Message Passing Interface.

Text Books

1. M.R. Bhujade, “Parallel Computing”, 2nd edition, New Age International Publishers 2009.
2. Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education, Inc., 2007, ISBN: 0-13-239227-5.

Reference Books

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design” (4th Edition), Addison Wesley/Pearson Education.
2. Pradeep K Sinha, “Distributed Operating Systems : Concepts and design”, IEEE computer society press

Course Code	Course/Subject Name	Credits
CPE8031	**Elective-III Machine Learning**	5

Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods, clustering methods.
3. To become familiar with support vector machine and Dimensionality reduction Techniques.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use Machine Learning Techniques.
2. Ability to understand regression, classification, clustering methods.
3. Ability to understand the difference between supervised and unsupervised learning methods.
4. Ability to appreciate Dimensionality reduction techniques.
5. Students would understand the working of Reinforcement learning.

Module	Detailed Contents	Hrs.
01	**Introduction to Machine Learning** 1.1 What is Machine Learning?, Key Terminology, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, How to choose the right algorithm, Steps in developing a Machine Learning Application.	06
02	**Learning with Regression** 2.1 Linear Regression, Logistic Regression.	04
03	**Learning with trees** 3.1 Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART).	08
04	**Support Vector Machines(SVM)** 4.1 Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	06
05	**Learning with Classification** 5.1 Rule based classification, classification by backpropoagation, Bayesian Belief networks, Hidden Markov Models.	06
06	**Dimensionality Reduction** 6.1 Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis.	06
07	**Learning with Clustering** 7.1 K-means clustering, Hierarchical clustering, Expectation Maximization	06

	Algorithm, Supervised learning after clustering, Radial Basis functions.	
08	**Reinforcement Learning** 8.1 Introduction, Elements of Reinforcement Learning, Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	06

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………..……………...	(15)	Marks.
• Assignments:…………..……………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

LIST OF ML PRACTICAL / EXPERIMENTS

1. To implement Linear Regression

2. To implement Logistic Regression

3. To implement ID3.

4. To implement Support Vector Machine.

5. To implement Bayesian Classification.

6. To implement K-Nearest Neighbour.

7. To implement k-means Clustering.

8. To implement Agglomerative Clustering.

Any other practical covering the syllabus topics and subtopics can be conducted.

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press

Reference Books:

1. William W.Hsieh, “Machine Learning Mehods in the Environmental Sciences”, Cambridge
2. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
3. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Course Code	Course/Subject Name	Credits
CPE8032	**Elective-III Embedded Systems**	5

Objectives:

1. Develop, among students, an understanding of the technologies behind the embedded computing systems; and to differentiate between such technologies.
2. Make aware of the capabilities and limitations of the various hardware or software components.
3. Evaluate design tradeoffs between different technology choices.
4. Complete or partial design of such embedded systems

Outcomes: Learner will be able to…

1. Describe the special requirements that are imposed on embedded systems
2. Describe the key properties of microprocessor and digital signal processor
3. Sketch a design of an embedded system around a microprocessor or DSP
4. Explain how microprocessor, memory, peripheral components and buses interact in an embedded system
5. Evaluate how architectural and implementation decisions influence performance and power dissipation
6. Produce efficient code for embedded systems
7. Point out the role of the compiler in the embedded system design process
8. Define the properties of a real-time operating system
9. Estimate the requirement for additional hardware for optimized performance
10. Understand and distinguish between the RISC and the Advanced RISC architecture
11. Utilize embedded systems to perform operations such as signal processing in real time
12. Develop drivers for external peripheral devices as per requirement.

Module	Detailed Contents	Hrs.
01	**Introduction to computational technologies** 1.1 Review of computation technologies (ARM, RISC, CISC, PLD, SOC), architecture, event managers, hardware multipliers, pipelining. Hardware/Software co-design. Embedded systems architecture and design process.	08
02	**Program Design and Analysis** 2.1 Integrated Development Environment (IDE), assembler, linking and loading. Program-level performance analysis and optimization, energy and power analysis and program size optimization, program validation and testing. Embedded Linux, kernel architecture, GNU cross platform tool chain. Programming with Linux environment.	08
03	**Process Models and Product development life cycle management** 3.1 State machine models: finite-state machines (FSM), finite-state machines with data-path model (FSMD), hierarchical/concurrent state machine	08

	model (HCFSM), program-state machine model (PSM), concurrent process model. Unified Modeling Language (UML), applications of UML in embedded systems. IP-cores, design process model. Hardware software co-design, embedded product development life cycle management.	
04	**High Performance 32-bit RISC Architecture** 4.1 ARM processor family, ARM architecture, instruction set, addressing modes, operating modes, interrupt structure, and internal peripherals. ARM coprocessors, ARM Cortex-M3.	08
05	**Processes and Operating Systems** 5.1 Introduction to Embedded Operating System, multiple tasks and multiple processes. Multi rate systems, preemptive real-time operating systems, priority-based scheduling, inter-process communication mechanisms. Operating system performance and optimization strategies. Examples of real-time operating systems.	08
06	**Real-time Digital Signal Processing (DSP)** 6.1 Introduction to Real-time simulation, numerical solution of the mathematical model of physical system. DSP on ARM, SIMD techniques. Correlation, Convolution, DFT, FIR filter and IIR Filter implementation on ARM. Open Multimedia Applications Platform (OMAP)	08

Term Work:

Term work should consist of at least 10 practicals and one mini project. Objective type term work test shall be conducted with a weightage of 10 marks.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/projects): ……….…….. (10) Marks.
- Mini project: …………………………………………… (10) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

The final certification and acceptance of Term Work ensures the satisfactory performance of laboratory work and minimum passing in term work.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

List of Experiments:

Topic-1: Troubleshooting Tools [Any One]

In-Circuit Emulator (ICE) and In-Circuit Debugger (ICD), Logic Analyzer, Spectrum Analyzer, Pattern generator and Digital Storage Oscilloscope.

Topic -2: ARM Processors & Interfaces [Any Four]

LEDs and Keyboard Interface, LCD Interface, Counting external events with on chip counters, Real Time Clock (RTC), Pulse Width Modulation (PWM), Relay and Buzzer Control for alarm events, Stepper Motor Control , On chip ADC/DAC SPI / I2C / UART Interface, Bluetooth/Zig-bee interface.

Topic-3: Real-time Signal Processing ARM-DSP [Any Two]

Real-time physical model simulation, Correlation, convolution, DFT, FIR or IIR design, Real-time DAS and GUI using PC and ARM, Design with Programmable Logic Devices (CPLD/FPGA).

Topic-4: Device Driver Development [Any One]

Drivers for CAN, Drivers for USB, Drivers for Ethernet, SVGA, Drivers for Graphics TFT LCD.

Topic-5: Real Time Operating System (RTOS) [Any Two]

RTLinux , MicroC/OS_II, VxWorks, WIN CE, QNX, Palm OS, Symbian OS, Android OS or equivalent OS.

Text Books:

1. Embedded Systems an Integrated Approach – Lyla B Das, Pearson
2. Computers as Components – Marilyn Wolf, Third Edition Elsevier
3. Embedded Systems Design: A Unified Hardware/Software Introduction – Frank Vahid and Tony Givargis, John Wiley & Sons
4. An Embedded Software Primer – David E. Simon – Pearson Education Sough Asia
5. ARM System Developer’s Guide Designing and Optimizing System Software – Andrew N. Sloss, Dominic Sysmes and Chris Wright – Elsevier Inc.

Reference Books:

1. Embedded Systems, Architecture, Programming and Design – Raj Kamal – Tata McGraw Hill
2. Embedded Linux – Hollabaugh, Pearson Education

3. Embedded Realtime Systems Programming – Sriram V Iyer, Pankaj Gupta – Tata McGRaw Hill.
4. Fundamentals of Microcontrollers and Applications in Embedded Systems – Ramesh Gaonkar – Penram International Publishing (India) Pvt. Ltd.
5. Embedded / Real-Time Systems: Concepts, Design & Programming – Dr. K. V. K. K. Prasad – Dreamtech Press, India.

Course Code	Course/Subject Name	Credits
CPE8033	**Elective-III Adhoc Wireless Networks**	5

Objectives:

1. To Identify the major issues associated with ad-hoc networks
2. To identify the requirements for protocols for wireless ad-hoc networks as compared to the protocols existing for wired network.
3. To explore current ad-hoc technologies by researching key areas such as algorithms, protocols, hardware, and applications.
4. To Provide hands-on experience through real-world programming projects
5. To provide advanced in –depth networking materials to graduate students in networking research.

Outcomes: Learner will be able to…

1. Define characteristics and features of Adhoc Networks
2. Appreciate the designing of MAC protocol for Adhoc networks
3. Implement few protocols
4. Apply security principles for routing

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to wireless Networks. Characteristics of Wireless channel, Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models. 1.2 Adhoc Networks: Introduction to adhoc networks – definition, characteristics features, applications.	04
02	**MAC Layer** 2.1 MAC Protocols for Ad hoc wireless Networks: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals and Classification of a MAC protocol, Contention based protocols with reservation mechanisms. 2.2 Scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, 802.16, HIPERLAN.	10
03	**Network Layer** 3.1 Routing protocols for Ad hoc wireless Networks: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table driven routing protocol, On-demand routing protocol. 3.2 Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.	10
04	**Transport Layer** 4.1 Transport layer protocols for Ad hoc wireless Networks: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless	07

	Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks, Other transport layer protocols for Ad hoc wireless Networks.	
05	**Security** 5.1 Security: Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning, Network security attacks, Key management, Secure routing in Ad hoc wireless Networks.	07
06	**QoS** 6.1 Quality of service in Ad hoc wireless Networks: Introduction, Issues and challenges in providing QoS in Ad hoc wireless Networks, Classification of QoS solutions, MAC layer solutions, network layer solutions.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:…………..………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

oral examination based on above syllabus will be conducted

Suggested Practicals for Adhoc Wireless

1. Installation of NS2 in Ubuntu 12.04 Linux.
2. Build and exchange data in simple infrastructure and Adhoc network by using personal computer and Android based mobile.
3. Develop sample wireless network in which

   a. implement AODV and AOMDV protocol

    b. Calculate the time to receive reply from the receiver using NS2.
    c. Generate graphs which show the transmission time for packet.
4. Implement wireless network. Capture data frame and identify fields using NS2.
5. Configure Wireless Access Point (WAP) and build different networks.
6. Implement Mobile device as a wireless access point.
7. Communicate between two different networks which has following specifications:
    a. One network has Class A network with “Tora protocol”
    b. Second has Class B network “AODV protocol”

Practical exam will be based on the above syllabus.

Text Books:

1. Siva Ram Murthy and B.S.Manoj, “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education, 2007
2. Charles E. Perkins, “Adhoc Networking”, Addison – Wesley, 2000
3. C. K. Toh,”Adhoc Mobile Wireless Networks”, Pearson Education, 2002

Reference Books:

1. Matthew Gast, “802.11 Wireless Networks: The Definitive Guide”, 2nd Edition, O'Reilly Media, April 2005.
2. Stefano Basagni, Marco Conti, Silvia Giordan and Ivan Stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE Press, 2004.
3. Mohammad Ilyas, “The handbook of Adhoc Wireless Networks”, CRC Press, 2002

Course Code	Course/Subject Name	Credits
CPE8034	**Elective-III Digital Forensics**	5

Objectives:

1. To focus on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence.
2. To provide hands on experience on various forensic tools and resources for system administrators and information system security officers.

Module	Detailed Contents	Hrs.
01	**Introduction:** 1.1 Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	09
02	**Initial Response and forensic duplication** 2.1 Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic. 2.2 Duplicate/Qualified Forensic Duplicate of a Hard Drive.	08
03	**Preserving and Recovering Digital Evidence** 3.1 File Systems: FAT, NTFS - Forensic Analysis of File Systems - Storage Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.	09
04	**Network Forensics** 4.1 Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud.	07
05	**System investigation** 5.1 Data Analysis Techniques - Investigating Live Systems (Windows & Unix) Investigating 5.2 Hacker Tools - Ethical Issues – Cybercrime.	08
06	**Bodies of law** 6.1 Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws , Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof : Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………………………..	(15)	Marks.
• Assignment: ……………………………………………	(05)	Marks.
• Attendance …………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

Oral exam will be based on the above syllabus.

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References:

1. Skoudis. E., Perlman. R. Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses.Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000
3. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics investigation “Course technology, 4th edition

Course Code	Course/Subject Name	Credits
CPE8035	**Elective III - Big Data Analytics**	5

Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Outcomes: Learner will be able to…

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Module	**Detailed Contents**	**Hrs.**
01	**Introduction to Big Data** 1.1 Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	03
02	**Introduction to Hadoop** 2.1 What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Physical Architecture; Hadoop limitations.	03
03	**NoSQL** 3.1 What is NoSQL? NoSQL business drivers; NoSQL case studies; 3.2 NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns; 3.3 Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	04
04	**MapReduce and the New Software Stack** **4.1 Distributed File Systems :** Physical Organization of Compute Nodes, Large-Scale File-System Organization. **4.2 MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks,	06

	Combiners, Details of MapReduce Execution, Coping With Node Failures. **4.3 Algorithms Using MapReduce**: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	
05	**Finding Similar Items** 5.1 Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem . 5.2 **Distance Measures:** Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	03
06	**Mining Data Streams** **6.1 The Stream Data Model**: A Data-Stream-Management System, Examples of Stream Sources, Stream Querie, Issues in Stream Processing. **6.2 Sampling Data in a Stream** : Obtaining a Representative Sample , The General Sampling Problem, Varying the Sample Size. **6.3 Filtering Streams**: The Bloom Filter, Analysis. **6.4 Counting Distinct Elements in a Stream** The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . **6.5 Counting Ones in a Window**: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	06
07	**Link Analysis** 7.1 PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 7.2 Topic sensitive Page Rank, link Spam, Hubs and Authorities.	05
08	**Frequent Itemsets** **8.1 Handling Larger Datasets in Main Memory** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multihash Algorithm. **8.2 The SON Algorithm and MapReduce** **8.3 Counting Frequent Items in a Stream** Sampling Methods for Streams, Frequent Itemsets in Decaying Windows	05
09	**Clustering** 9.1 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries	05

10	**Recommendation Systems** 10.1 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	04
11	**Mining Social-Network Graphs** 11.1 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, SimRank, Counting triangles using Map-Reduce	04

Term Work:

Assign a case study for group of 2/3 students and each group to perform the following experiments on their case-study; Each group should perform the exercises on a large dataset created by them.

The distribution of marks for term work shall be as follows:

• Programming Exercises: ………………………..…..	(10)	Marks.
• Mini project: …………………………………………	(10)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

An oral exam will be held based on the above syllabus.

Suggested Practical List: Students will perform at least 8 programming exercises and implement one mini-project. The students can work in groups of 2/3.

1. Study of Hadoop ecosystem
2. programming exercises on Hadoop
3. programming exercises in No SQL
4. Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication, Aggregates, joins, sorting, searching etc.
5. Implementing any one Frequent Itemset algorithm using Map-Reduce
6. Implementing any one Clustering algorithm using Map-Reduce
7. Implementing any one data streaming algorithm using Map-Reduce
8. Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web)

a. Twitter data analysis
b. Fraud Detection
c. Text Mining etc.

Text Books:

1. Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press,
2. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly “Making Sense of NoSQL” – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks **, “**Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley
2. Chuck Lam, “Hadoop in Action”, Dreamtech Press

Course Code	Course/Subject Name	Credits
CPL801	**Cloud Computing Laboratory**	1

Outcomes: Learner will be able to…

1. Appreciate cloud architecture
2. Create and run virtual machines on open source OS
3. implement Infrastructure , storage as a Service.
4. Install and appreciate security features for cloud

Module	**Detailed Contents**	**Lab Session**
01	**Title:** Study of Cloud Computing & Architecture. **Concept:** Cloud Computing & Architecture. **Objective:** Objective of this module is to provide students an overview of the Cloud Computing and Architecture and different types of Cloud Computing **Scope:** Cloud Computing & Architecture Types of Cloud Computing . **Technology: ---**	**01**
02	**Title:** Virtualization in Cloud. **Concept:** Virtualization **Objective:** In this module students will learn, Virtualization Basics, Objectives of Virtualization, and Benefits of Virtualization in cloud. **Scope:** Creating and running virtual machines on open source OS. **Technology:** KVM, VMware.	**02**
03	**Title:** Study and implementation of Infrastructure as a Service . **Concept:** Infrastructure as a Service. **Objective:** In this module student will learn Infrastructure as a Service and implement it by using OpenStack. **Scope:** Installing OpenStack and use it as Infrastructure as a Service . **Technology:** Quanta Plus /Aptana /Kompozer	**02**
04	**Title:** Study and installation of Storage as Service.	**02**

	Concept: Storage as Service (SaaS) **Objective:** is that, students must be able to understand the concept of SaaS , and how it is implemented using ownCloud which gives universal access to files through a web interface. **Scope:** is to installation and understanding features of ownCloud as SaaS**.** **Technology:** ownCloud	
05	**Title:** Implementation of identity management. **Concept:** Identity Management in cloud **Objective:** this lab gives an introduction about identity management in cloud and simulate it by using OpenStack **Scope:** installing and using identity management feature of OpenStack **Technology:** OpenStack	**02**
06	**Title:** Write a program for web feed. **Concept:** Web feed and RSS **Objective:** this lab is to understand the concept of form and control validation **Scope:** Write a program for web feed **Technology:** PHP, HTML	**02**
07	**Title:** Study and implementation of Single-Sing-On. **Concept:** Single Sing On (SSO),openID **Objective:** is to understand the concept of access control in cloud and single sing on (SSO), Use SSO and advantages of it, and also students should able to implementation of it. **Scope:** installing and using JOSSO **Technology:** JOSSO	**02**
08	**Title:** Securing Servers in Cloud. **Concept:** Cloud Security **Objective:** is to understand how to secure web server, how to secure data directory and introduction to encryption for own cloud.	**02**

	Scope: Installing and using security feature of ownCloud **Technology:** ownCloud	
09	**Title:** User Management in Cloud. **Concept:** Administrative features of Cloud Managenet ,User Management **Objective:** is to understand how to create, manage user and group of users accounts. **Scope:** Installing and using Administrative features of ownCloud **Technology:** ownCloud	**02**
10	**Title:** Case study on Amazon EC2. **Concept:** Amazon EC2 **Objective:** in this module students will learn about Amazon EC2. Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. EC2 allows users to rent virtual computers on which to run their own computer applications	**01**
11	**Title:** Case study on Microsoft azure. **Concept:** Microsoft Azure **Objective:** students will learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. **Technology:** Microsoft azure	**01**
12	**Title:** Mini project. **Concept:** using different features of cloud computing creating own cloud for institute, organization etc. **Objective:** is student must be able to create own cloud using different features which are learned in previous practices. **Scope:** creating a cloud like social site for institute. **Technology:** any open system used for cloud	**05**

Term Work:

- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………………………..	(15)	Marks.
• Mini project presentation: …………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: ……………………………………………	**(25)**	**Marks.**

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 , ISBN:978-0-470-58987-8
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013
4. www.openstack.org

Course Code	Course/Subject Name	Credits
CP701 / CP802	**Project I/ II**	**3 / 6**

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
    - Quality of problem selected
    - Clarity of Problem definition and Feasibility of problem solution
    - Relevance to the specialization
    - Clarity of objective and scope
    - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
    - Quality of problem selected
    - Clarity of Problem definition and Feasibility of problem solution
    - Relevance to the specialization / Industrial trends
    - Clarity of objective and scope
    - Quality of work attempted
    - Validation of results
    - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions

Program Structure B.E. Computer Engineering

Fourth Year (Computer) (Semester VII)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC701	Digital Signal Processing	4	2	-	4	1	-	5
CPC702	Cryptography and System Security	4	2	-	4	1	-	5
CPC703	Artificial Intelligence	4	2	-	4	1	-	5
CPE7042X	Elective-II	4	2	-	4	1	-	5
CPP701	Project I	-	-	-	-	3	-	3
CPL701	Network Threats and Attacks Laboratory	-	4	-	-	2	-	2
	Total	**16**	**12**	**-**	**16**	**09**	-	**25**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Tot
		Test 1	Test 2	Avg					
CPC701	Digital Signal Processing	20	20	20	80	03	25	-	125
CPC702	Cryptography and System Security	20	20	20	80	03	25	25 (prac	150
CPC703	Artificial Intelligence	20	20	20	80	03	25	25	150
CPE7042X	Elective-II	20	20	20	80	03	25	25	150
CPP701	Project I	-	-	-	-	-	50	50	100
CPL701	Network Threats and Attacks Laboratory	-	-	-	-	-	25	50	50
	Total	**-**	**-**	**80**	**320**	-	**200**	**175**	**775**

Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester VIII)

(REV 201)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC801	Data Warehouse and Mining	4	2	-	4	1	-	5
CPC802	Human Machine Interaction	4	2	-	4	1	-	5
CPC803	Parallel and distributed Systems	4	2	-	4	1	-	5
CPE803X	Elective-III	4	2	-	4	1	-	5
CPP802	Project II	-	-	-	-	6	-	6
CPL801	Cloud Computing Laboratory	-	2	-	-	1	-	1
	Total	**16**	**10**	**-**	**16**	**11**	-	**27**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Tot
		Test 1	Test 2	Avg					
CPC801	Data Warehouse and Mining	20	20	20	80	03	25	25	150
CPC802	Human Machine Interaction	20	20	20	80	03	25	25	150
CPC803	Parallel and distributed Systems	20	20	20	80	03	25	25	150
CPE803X	Elective-III	20	20	20	80	03	25	25	150
CPP802	Project II	-	-	-	-	-	50	50	100
CPL801	Cloud Computing Laboratory	-	-	-	-	-	25	-	-
	Total			80	320		175	150	725

Elective I Sem 6

CPE6011 Operation Research

CPE6012 Project Management

CPE6013 Foreigh Language – German

CPE6014 Foreigh Language – French

Elective II Sem 7

System Group	**CPE7021**	Advance Algorithms
	CPE7022	Computer Simulation and Modeling
Electronics Group	**CPE7023**	Image Processing
Software Group	**CPE7024**	Software Architecture
	CPE7025	Soft Computing
DB Group	**CPE7026**	ERP and Supply Chain Management

Elective III - Sem 8

Electronics Group	**CPE8031**	Machine Learning
Digital Group	**CPE8032**	Embedded Systems
Network Group	**CPE8033**	Adhoc wireless networks
	CPE8034	Digital Forensic
DB Group	**CPE8035**	Big data Analytics

Course Code	Course/Subject Name	Credits
CPC701	**Digital Signal Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Signal Processing.
2. To explore the properties of DFT in mathematical problem solving.
3. To illustrate FFT calculations mathematically and develop FFT based DSP algorithms.
4. To introduce DSP processor for real time signal processing application

Outcomes: Learner will be able to…

1. To understand the concept of DT Signal and perform signal manipulation
2. To perform analysis of DT system in time domain
3. To develop FFT flow-graph and Fast DSP Algorithms.
4. To design DSP system for Real Time Signal Processing.

Module	Detailed Contents	Hrs.
01	**Discrete Time Signal** 1.1 Introduction to Digital Signal Processing, Discrete Time Signals, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations(shifting, addition, subtraction, multiplication), Classification of Signals, Linear Convolution formulation(without mathematical proof), Circular Convolution formulation(without mathematical proof), Matrix Representation of Circular Convolution, Linear by Circular Convolution. Auto and Cross Correlation formula evaluation,	12
02	**Discrete Time System** 2.1 Introduction to Discrete Time System, Classification of DT Systems (Linear/Non Linear, Causal/Non Causal, Time Invariant/Time Variant Systems, Stable/ Unstable), BIBO Time Domain Stability Criteria. LTI system, Concept of Impulse Response and Step Response. 2.2 Concept of IIR System and FIR System, Output of IIR and FIR DT system using Time Domain Linear Convolution formula Method.	08
03	**Discrete Fourier Transform** 3.1 Introduction to DTFT, DFT, Relation between DFT and DTFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. 3.2 Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT. Response of FIR system calculation in frequency domain using DFT.	08
04	**Fast Fourier Transform** 4.1 Radix-2 DIT-FFT algorithm, DIT-FFT Flowgraph for N=4, 6 & 8, Inverse	06

	FFT algorithm. Spectral Analysis using FFT, Comparison of complex and real, multiplication and additions of DFT and FFT.	
05	**DSP Algorithms** 5.1 Carls' Correlation Coefficient Algorithm, Fast Circular Convolution Algorithm, Fast Linear Convolution Algorithm, Linear FIR filtering using Fast Overlap Add Algorithm and Fast Overlap Save Algorithm,	08
06	**DSP Processors and Application of DSP** 6.1 Need for Special architecture of DSP processor, Difference between DSP processor & microprocessor, A general DSP processor TMS320C54XX series, Case study of Real Time DSP applications to Speech Signal Processing and Biomedical Signal Processing.	06

List of Experiments:

Implementation of programs must be either in C or C++ only. Application can be developed using open source simulation software such as Scilab. A List of compulsory eight experiments is given below. Additional experiments within the scope of the syllabus can be added.

1. Sampling and Reconstruction

Aim:
To study sampling and reconstruction of signal

Objective:
Develop a program to sample a continuous time signal and convert it to Discrete Time Signal.

Problem Definition:

1. Sample the input signal and display first 50 samples. Calculate data rate and bit rate.
2. Reconstruct the original signal and display the original and reconstructed signals.
3. Vary the sampling frequency and observe the change in the quality of reconstructed signal.

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2. To perform Discrete Correlation

Aim:
To study mathematical operation Correlation and measure degree of similarity between two signals

Objective:

1. Write a function to find correlation operation.
2. Calculate correlation of a DT signals and verify the results using mathematical formulation.
3. Measure the degree of similarity using Carl's Correlation Coefficient formula in time domain.

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find auto correlation of input signal. What is the significance of value of output signal value at n=0?.
2. Find auto correlation of delayed input signal.
3. Find cross correlation of input signal and delayed input signal,
4. Find cross correlation of input signal and scaled delayed input signal.
5. Compare the resultant signals. Give your conclusion.
6. Take two input finite length DT signals and develop a function to find Carl's Correlation Coefficient value. Determine the degree of similarity of two signals from the calculated Carl's Correlation Coefficient value.

3. To perform Discrete Convolution

Aim:

The aim of this experiment is to study mathematical operation such as Linear convolution, Circular convolution, Linear convolution using circular convolution.

Objective:

1. Develop a function to find Linear Convolution and Circular Convolution
2. Calculate Linear Convolution, Circular Convolution, Linear Convolution using Circular Convolution and verify the results using mathematical formulation.
3. Conclude on aliasing effect in Circular convolution

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find Linear Convolution and Circular Convolution of L point sequence x[n] and M point sequence h[n].
2. Find Linear Convolution of L point sequence x[n] and M point sequence h[n] using Circular convolution.
3. Give your conclusion about No of values in linearly convolved signal, and Aliasing effect in Circular Convolution.

4. To perform Discrete Fourier Transform

Aim:
The aim of this experiment is to study magnitude spectrum of the DT signal.

Objective:

1. Develop a function to perform DFT of N point signal
2. Calculate DFT of a DT signal and Plot spectrum of the signal.
3. Conclude the effect of zero padding on magnitude spectrum.
4. Calculate the number of real multiplications and real additions required to find DFT.

Input Specifications:

1. Length of Signal N
2. Signal values

Problem Definition:

1. Take any four-point sequence x[n].

- Find DFT X[k].
- Compute number of real multiplications and real additions required to find X[k].
- Plot Magnitude Spectrum of the signal.

2. Append the input sequence by four zeros. Find DFT and plot magnitude spectrum. Repeat the same by appending the sequence by eight zeros. Observe and compare the magnitude spectrum. Give your conclusion.

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5. To perform Fast Fourier Transform

Aim:
To implement computationally fast algorithms.

Objective:
1. Develop a program to perform FFT of N point signal.
2. Calculate FFT of a given DT signal and verify the results using mathematical formulation.
3. Illustrate the computational efficiency of FFT.

Input Specifications:

- Length of Signal N
- Signal values

Problem Definition:
Take any eight-point sequence x[n].

- Find FFT X[k].
- Write number of real multiplications and real additions involved in finding X[k].

6. Filtering of long Data Sequence

Aim:

To perform filtering of Long Data Sequence using Overlap Add Method and Overlap Save Method.

Objective:

Develop a function to implement Fast Overlap Add and Fast Overlap Save Algorithm using FFT.

Input Specifications:

1. Length of long data sequence and signal values.
2. Length of impulse response M and coefficient values of h[n].

Problem Definition:

Find the output of a Discrete Time system using Fast Overlap Add Method OR Fast Overlap Save Method.

7. Real Time Signal Processing

Aim:

To perform real time signal processing using TMS320 Processor.

Objective:

Study real time signal processing.

Input Specifications:

1. Real Time Speech Signal

Problem Definition:

1) Capture the real time audio signal.
2) Filter it by convolving input signal with the impulse response of FIR filter using Fast Overlap Add filtering Algorithm OR Fast Overlao Save Filtering Algorithm.
3) Observe the quality of output signal.

8. Application of Digital Signal Processing

Aim:

To implement any Signal Processing operation on one dimensional signal.

Objective:
To develop application of signal processing.

Input Specifications:
One dimensional signal.

Rules:

1. Number of students in one Group : min - 2 max -3
2. Decide one DSP application of your choice. Collect the information related to the application from the published granted patents. Download the related published papers from the standard refereed journals and conferences.
3. Develop a block diagram of the proposed system and flowchart of proposed system algorithm, implement it using Scilab/C, C++ language and obtain the appropriate results.
4. Prepare the three to four pages report on the mini project in IEEE paper format. Report should include Abstract, Introduction, Related Theory, Proposed System Design/Algorithm, Experimentation & Result Analysis, Conclusion, and References.
5.

Term Work:

- Term work shall consist of minimum **08** assignments and course project.
- Journal must include at least 1 assignment on each module and two quiz.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:……………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Text Books :

1. Ashok Ambardar, ‘Digital Signal Processing’, Cengage Learning, 2007, ISBN : 978-81-315-0179-5.

2. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education ISBN 0-201-59619- 9

3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, ‘Digital Signal Processing’ TataMcgraw Hill Publication First edition (2010). ISBN 978-0-07-066924-6.

4. Avtar Signh, S.Srinivasan,”Digital Signal Processing’, Thomson Brooks/Cole, ISBN : 981-243-254-4

Reference Books :

1. B. Venkatramani, M. Bhaskar ,”Digital Signal Processor’, TataMcGraw Hill, Second Edition, (2001). ISBN : 978-0-07-070256-1.

2. Sanjit Mitra, ‘Digital Signal Processing : A Computer Based Approach’ , TataMcGraw Hill, Third Edition

3. Dr, Shaila Apte, “Digital Signal Processing,”, Wiley India, Second Edition,2013 ISBN : 978-81-2652142-5

4. Proakis Manolakis, ‘Digital Signal Processing : Principles, Algorithms and Applications’ Fourth 2007, Pearson Education, ISBN 81-317-1000-9.

5. Monson H. Hayes, “Schaums Outline of Digital Signal Processing’ McGraw Hill International second edition. ISBN : 978-00-7163509-7

Course Code	Course/Subject Name	Credits
CPC702	**Cryptography and System Security**	5

Objectives:

1. To provide students with contemporary knowledge in Cryptography and Security.
2. To understand how crypto can be used as an effective tools in providing assurance concerning privacy and integrity of information.
3. To provide skills to design security protocols for recognize security problems.

Outcomes: Learner will be able to…

1. Understand the principles and practices of cryptographic techniques.
2. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for given application.
3. Appreciate the application of security techniques and technologies in solving real-life security problems in practical systems.
4. Apply appropriate security techniques to solve security problem
5. Design security protocols and methods to solve the specific security problems.
6. Familiar with current research issues and directions of security.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Security Attacks, Security Goals, Computer criminals, Methods of defense, Security Services, Security Mechanisms	06
02	**Basics of Cryptography** 2.1 Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties- Confusion, Diffusion, Block and Stream Ciphers.	06
03	**Secret Key Cryptography** 3.1 Data Encryption Standard(DES), Strength of DES, Block Cipher Design Principles and Modes of Operations, Triple DES, International Data Encryption algorithm, Blowfish, CAST-128.	06
04	**Public Key Cryptography** 4.1 Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange	04
05	**Cryptographic Hash Functions** 5.1 Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Authentication Protocols, Digital Signature Standards.	06
06	**Authentication Applications** 6.1 Kerberos, Key Management and Distribution, X.509 Directory Authentication service, Public Key Infrastructure, Electronic Mail Security: Pretty Good Privacy, S/MIME.	06

07	**7.1 Program Security** Secure programs, Nonmalicious Program Errors, Malicious Software – Types, Viruses, Virus Countermeasures, Worms, Targeted Malicious Code, Controls against Program Threats. **7.2 Operating System Security** Memory and Address protection, File Protection Mechanism, User Authentication. **7.3 Database Security** Security Requirement, Reliability and Integrity, Sensitive data, Inference, Multilevel Databases **7.4 IDS and Firewalls** Intruders, Intrusion Detection, Password Management, Firewalls-Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration, Trusted systems.	08
08	**8.1 IP Security** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining security Associations, Internet Key Exchange, Web Security: Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Electronic Payment. **8.2 Non-cryptographic protocol Vulnerabilities** DoS, DDoS, Session Hijacking and Spoofing, Software Vulnerabilities-Phishing, Buffer Overflow, Format String Attacks, SQL Injection.	06

Term Work:

Term work should consist of at least 10experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ………….……….. (15) Marks.
- Assignment:……………………………………..…… (05) Marks.
- Attendance (Theory+ Practical)……………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Practical Exam will be based on above syllabus.

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. RSA and MD5 algorithms.
2. Packet Analyzer.

3. IPSec
4. Spoofing
5. PGP(Pretty Good Privacy)
6. Port Scanning
7. Vulnerability scanner
8. Buffer Overflow
9. Intrusion Detection System
10. Password cracking
11. Firewall
12. SSL

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Cryptography and Network Security: Principles and Practice 5th edition, William Stallings, Pearson.
2. Network Security and Cryptography 2nd edition, Bernard Menezes, Cengage Learning.
3. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

Reference Books:

1. Cryptography and Network Security by Behrouz A. Forouzan, TMH
2. Security in Computing by Charles P. Pfleeger, Pearson Education.
3. Computer Security Art and Science by Matt Bishop, Addison-Wesley.

Course Code	Course/Subject Name	Credits
CPC703	**Artificial Intelligence**	5

Objectives:

1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2. To make students understand and Explore the mechanism of mind that enable intelligent thought and action.
3. To make students understand advanced representation formalism and search techniques.
4. To make students understand how to deal with uncertain and incomplete information.

Outcomes: Learner will be able to

1. Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2. Ability to choose an appropriate problem solving method and knowledge representation technique.
3. Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4. Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5. Ability to design and develop the AI applications in real world scenario.

Module	Detailed Contents	Hrs
01	**Introduction to Artificial Intelligence** 1.1 Introduction , History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.	04
02	**Intelligent Agents** 2.1 Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	04
03	**Problem solving** 3.1 Solving problem by Searching : Problem Solving Agent, Formulating Problems, Example Problems. 3.2 Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS) , Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bounded heuristic Search. 3.3 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search,	14

	Genetic algorithms. 3.4 Adversarial Search: Games, Optimal strategies, The minimax algorithm , Alpha-Beta Pruning.	
04	**Knowledge and Reasoning** 4.1 Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining. 4.2 Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG). 4.3 **Uncertain Knowledge and Reasoning:** Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	12
05	**Planning and Learning** 5.1The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. 5.2 Learning: Forms of Learning, Inductive Learning, Learning Decision Tree. 5.3 Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	10
06	**Applications** 6.1 Natural Language Processing(NLP), Expert Systems.	04

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/case studies): …………..	(15)	Marks.
• Assignment:………..…………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

There will be at least two assignments covering the above syllabus.

Practical/Oral examination:

Practical examination based on the above syllabus will be conducted.

List of AI Practical / Experiments

All the programs should be implemented in C/C++/Java/Prolog under Windows or Linux environment. Experiments can also be conducted using available open source tools.

1. One case study on NLP/Expert system based papers published in IEEE/ACM/Springer or any prominent journal.

2. Program on uninformed and informed search methods.

3. Program on Local Search Algorithm.

4. Program on Optimization problem.

5. Program on adversarial search.

6. Program on Wumpus world.

7. Program on unification.

8. Program on Decision Tree.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (Practicals):

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight "Artificial Intelligence "Third Edition
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach “Second Edition" Pearson Education.
2. Saroj Kaushik “Artificial Intelligence” , Cengage Learning.
3. George F Luger “Artificial Intelligence” Low Price Edition , Pearson Education., Fourth edition.

Reference Books:

1. Ivan Bratko “PROLOG Programming for Artificial Intelligence”, Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight “Artificial Intelligence” Third Edition
3. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, “Neural Network Design” CENGAGE Learning, India Edition.
5. Patrick Henry Winston , “Artificial Intelligence”, Addison-Wesley, Third Edition.
6. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.
7. N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.

Course Code	Course/Subject Name	Credits
CPE7021	**Advanced Algorithms**	5

Objectives:

1. To teach fundamentals of analysis of algorithm at depth
2. To provide in depth study of advanced data structures and its uses
3. To teach analysis of problems from different domains

Outcomes: Learner will be able to…

1. Identify and use suitable data structures for given problem from different domains
2. Appreciate the role of Graph algorithms in solving variety of problems
3. Appreciate the role of Optimization by using linear programing
4. Analyze the various algorithms from different domains

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Asymptotic notations Big O, Big Θ,Big Ω,o ,ω notations ,Proofs of master theorem, applying theorem to solve problems	03
02	**Advanced Data Structures** 2.1 Red-Black Trees: properties of red-black trees , Insertions , Deletions 2.2 B-Trees and its operations 2.3 Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps	09
03	**Dynamic Programing** 3.1 matrix chain multiplication, cutting rod problem and its analysis	06
04	**Graph algorithms** 4.1 Bellman ford algorithm, Dijkstra algorithm, Johnson's All pair shortest path algorithm for sparse graphs	06
05	**Maximum Flow** 5.1 Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08
06	**Linear Programing** 6.1 Standard and slack forms, Formulating problems as linear programs, simplex algorithm, Duality, Initial basic feasible solution	08
07	**Computational Ggeometry** 7.1 Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08

Term Work:

Term work should consist of at least 6 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:…………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral examination based on above syllabus will be conducted

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Red – black trees and its various operations
2. Binomial Heaps and its various operations
3. Dynamic programing: matrix chain multiplication , cutting rod example
4. Bellman ford , Johnson’s algorithm for sparse graphs
5. Ford Fulkerson algorithm , push relabel to front methods
6. Finding closest pair of points, Determining the convex hull
7. Implementation of Simplex algorithm

Text Books:

1. T.H. Coreman , C.E. Leiserson, R.L. Rivest, and C. Stein, “Introduction to algorithms”,2nd edition , PHI publication 2005
2. Ellis Horowitz , Sartaj Sahni , S. Rajsekaran. “Fundamentals of computer algorithms” University press

Course Code	Course/Subject Name	Credits
CPE7023	**Image Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Image Processing and Video Processing .
2. To understand basic image enhancement and segmentation techniques.
3. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
4. To learn Image Compression and Decompression Techniques

Outcomes: Learner will be able to…

1. Understand the concept of Digital Image and Video Image.
2. Explain image enhancement and Segmentation technique.
3. Develop fast image transform flowgraph
4. Solve Image compression and decompression techniques
5. Perform Binary Image Processing Operations

Module	Detailed Contents	Hrs.
01	**Digital Image and Video Fundamentals** 1.1 Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization, Representation of Digital Image, Connectivity, Image File Formats : BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV) Introduction to Digital Video, Chroma Sub-sampling, CCIR standards for Digital Video	06
02	**Image Enhancement** 2.1 Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Neighbourhood Processing, Spatial Filtering, Smoothing and Sharpening Filters. Homomorphic Filtering	09
03	**Image Segmentation and Representation** 3.1 Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Moments.	09
04	**Image Transform** 4.1 Introduction to Unitary Transform, Discrete Fourier Transform(DFT), Properties of DFT, Fast Fourier Transform(FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	09
05	**Image Compression** 5.1 Introduction, Redundancy, Fidelity Criteria, 5.2 Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	09

	5.3 Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	
06	**Binary Image Processing** 6.1 Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm	06

Term Work:

Term work should consist of at least 08 experiments.
Journal must include at least 1 assignment on each module and two quiz.
The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): …………..……….. (15) Marks.
- Assignment:……………………………………..…… (05) Marks.
- Attendance (Theory+ Practical)……………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral exam will be based on the above syllabus

Practicals

Implementation of programs must be either in C or C++ only. A List of experiments is given below. Input can be Monochrome OR Colour Image. Additional experiments within the scope of the syllabus can be added.

1. Image Enhancement [Any two techniques]
   (1) using Zero Memory Point Operations.
   (2) using Histogram Processing Technique
   (3) using Spatial Filtering [Smoothing Filters/ Sharpening Filters]
   (4) using Homomorphic Filtering

2. Image Segmentation [Any two techniques]

(1) Horizontal and Vertical Line Detection
(2) Edge Detection
(3) Split and Merge Technique
(4) Edge Linking using Hough Transform

3. Image Compression and De-compression [Any two techniques]
(1) Arithmetic Coding and Decoding
(2) Huffman Coding and Decoding
(3) IGS Quantization/ Vector Quantization based Compression and De-compression
(4) Transform based Image Compression and De-compression [FFT/ FHT/DCT/ DWT]

4. Binary Image Processing [Any two techniques]
    (1) Opening followed by Closing
    (2) Hit or Miss Transform
    (3) Thinning/Thickening/ Region Fillling / Boundary Extraction
    (4) Connected Component Algorithm

Text Books :

1. Rafel C. Gonzalez and Richard E. Woods, ‘Digital Image Processing’, Pearson Education Asia, Third Edition, 2009,

2. S. Jayaraman, E.Esakkirajan and T.Veerkumar, “Digital Image Processing” TataMcGraw Hill Education Private Ltd, 2009,

3. Anil K. Jain, “Fundamentals and Digital Image Processing”, Prentice Hall of India Private Ltd, Third Edition

4. S. Sridhar, “Digital Image Processing”, Oxford University Press, Second Edition, 2012.

5. Robert Haralick and Linda Shapiro, “Computer and Robot Vision”, Vol I, II, Addison Wesley, 1993.

Reference Books:

1. Dwayne Phillps, “Image Processing in C”, BPB Publication, 2006

2. B. Chandra and D.Dutta Majumder, “Digital Image Processing and Analysis”, Prentice Hall of India Private Ltd, 2011

3. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, Prentice Hall of India Private Ltd, Third Edition

4. Fred Halshall, “Multimedia Communications: Applications, Networks Protocols and Standards,”, Pearson Education 2001

5. David A. Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, Pearson Education, Limited, 2011

Course Code	Course/Subject Name	Credits
CPE7024	**Software Architecture**	5

Outcomes:
Software architecture is foundational to the development of large, practical software-intensive applications.
After successful completion of this course learner will be able to:

- Visualize the architectural concepts in development of large, practical software-intensive applications.
- Rather than focusing on one method, notation, tool, or process, this new course widely surveys software architecture techniques, enabling us to choose the right tool for the job at hand.

Module	Detailed Contents	Hrs.
01	**Basic Concepts** 1.1 Concepts of Software Architecture 1.2 Models. 1.3 Processes. 1.4 Stakeholders	03
02	**Designing Architectures** 2.1 The Design Process. 2.2 Architectural Conception. 2.3 Refined Experience in Action: Styles and Architectural Patterns. 2.4 Architectural Conception in Absence of Experience.	02
03	**Connectors** 3.1 Connectors in Action: A Motivating Example. 3.2 Connector Foundations. 3.3 Connector Roles. 3.4 Connector Types and Their Variation Dimensions. 3.5 Example Connectors.	06
04	**Modeling** 4.1 Modeling Concepts. 4.2 Ambiguity, Accuracy, and Precision. 4.3 Complex Modeling: Mixed Content and Multiple Views. 4.4 Evaluating Modeling Techniques. 4.5 Specific Modeling Techniques.	04
05	**Analysis** 5.1 Analysis Goals. 5.2 Scope of Analysis. 5.3 Architectural Concern being Analyzed. 5.4 Level of Formality of Architectural Models.	08

	5.5 Type of Analysis. 5.6 Analysis Techniques.	
06	**Implementation and Deployment** 6.1 Concepts. 6.2 Existing Frameworks. 6.3 Software Architecture and Deployment. 6.4 Software Architecture and Mobility.	04
07	**Conventional Architectural styles** 7.1 Pipes and Filters 7.2 Event- based, Implicit Invocation 7.3 Layered systems 7.4 Repositories 7.5 Interpreters 7.6 Process control	05
08	**Applied Architectures and Styles** 8.1 Distributed and Networked Architectures. 8.2 Architectures for Network-Based Applications. 8.3 Decentralized Architectures. 8.4 Service-Oriented Architectures and Web Services.	08
09	**Designing for Non-Functional Properties** 9.1 Efficiency. 9.2 Complexity. 9.3 Scalability and Heterogeneity. 9.4 Adaptability. 9.5 Dependability.	04
10	**Domain-Specific Software Engineering** 10.1 Domain-Specific Software Engineering in a Nutshell. 10.2 Domain-Specific Software Architecture. 10.3 DSSAs, Product Lines, and Architectural Styles.	04

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments):……………………..	(20)	Marks.
• Attendence:…….………………………………………	(05)	Marks.
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

An Oral examination is to be conducted based on the above syllabus

Topics For Experiment:

1. Modeling using xADL
2. Analysis - Case study
3. Visualization using xADL 2.0
4. Integrate software components using a middleware
5. Use middleware to implement connectors
6. Wrapper to connect two applications with different architectures
7. Creating web service
8. Architecture for any specific domain

Books:

Text Books:

1. “Software Architecture: Foundations, Theory, and Practice” by Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, ISBN: 978-0-470-16774-8
2. M. Shaw: Software Architecture Perspectives on an Emerging Discipline, Prentice-Hall.
3. Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice, Pearson.

References:

1. “Pattern Oriented Software Architecture” by Frank Buchnan et al, Wiley India.
2. “The Art of Software Architecture” by Stephen T. Albin.

Course Code	Course/Subject Name	Credits
CPE7025	**Soft Computing**	5

Objectives:

1. To Conceptualize the working of human brain using ANN.
2. To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
3. To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
4. To provide the mathematical background for carrying out the optimization and familiarizing genetic algorithm for seeking global optimum in self-learning situation.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use fuzzy logic.
2. Ability to design inference systems.
3. Ability to understand the difference between learning and programming and explore practical applications of Neural Networks (NN).
4. Ability to appreciate the importance of optimizations and its use in computer engineering fields and other domains.
5. Students would understand the efficiency of a hybrid system and how Neural Network and fuzzy logic can be hybridized to form a Neuro-fuzzy network and its various applications.

Module	Detailed Contents	Hours
01	**Introduction to Soft Computing** 1.1 Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	**04**
02	**Neural Networks** **2.1 Basics of Neural Networks:** Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model, **2.2 Supervised Learning algorithms:** Perceptron (Single Layer, Multi layer), Linear separability, Delta learning rule, Back Propagation algorithm, **2.3 Un-Supervised Learning algorithms:** Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	**14**

03	**Fuzzy Set Theory** 3.1 Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of membership function, Fuzzy extension principle, Fuzzy Systems- fuzzification, defuzzification and fuzzy controllers.	**14**
04	**Hybrid system** 4.1 Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System(ANFIS).	**04**
05	**Introduction to Optimization Techniques** **5.1 Derivative based optimization-** Steepest Descent, Newton method. **5.2 Derivative free optimization-** Introduction to Evolutionary Concepts.	**06**
06	**Genetic Algorithms and its applications:** 6.1 Inheritance Operators, Cross over types, inversion and Deletion, Mutation Operator, Bit-wise Operators, Convergence of GA, Applications of GA.	**06**

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/case studies): …………..	(15)	Marks.
• Assignments:…………………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral examination will be based on the above syllabus.

PRACTICALS:

All the programs should be implemented in C/C++/Java/MATLAB under Windows or Linux environment. Experiments can also be conducted using available open source tools like OCTAVE and SCILAB

LIST OF SC PRACTICAL / EXPERIMENTS

1. One case study on Fuzzy/Neural/GA based papers published in IEEE/ACM/Springer or any prominent journal.

2. To implement Fuzzy Sets.

3. To implement Fuzzy Relations.

4. To implement Fuzzy Controllers.

5. To implement Basic Neural Network learning rules.

6. To implement any Supervised Learning algorithm.

7. To implement any Unsupervised Learning algorithm.

8. To implement a simple application using Genetic Algorithm.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (for practicals) :

1. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
2. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
3. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.

4. Satish Kumar, “Neural Networks –A classroom approach”, Second Edition,TMH Publication.

Text Books:

1. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.
2. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
3. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
4. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
5. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

Reference Books:

1. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
2. Zimmermann H.S "Fuzzy Set Theory and its Applications" Kluwer Academic Publishers.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.

Course Code	Course/Subject Name	Credits
CPE7026	**Enterprise Resource Planning and Supply Chain Management (ERP & SCM)**	5

Objectives:

1. To understand the technical aspects of ERP and SCM systems.
2. To understand the steps and activities in the ERP and SCM life cycle.
3. To identify and describe typical functionality in an ERP and SCM system.
4. To understand tools and methodology used for designing ERP and SCM for an Enterprise.

Outcomes: Learner will be able to…

1. To conceptualize the basic structure of ERP and SCM
2. To identify implementation strategy used for ERP and SCM.
3. To apply design principles for various business module in ERP and SCM.
4. To apply different emerging technologies for implementation of ERP and SCM.

Module	Detailed Contents	Hours
Enterprise Resource Planning		
01	**Introduction** 1.1 What is an Enterprize, Introduction to ERP, Need for ERP, Structure of ERP, Scope and Benefits, Typical business processes.	02
02	**ERP and Technology** 2.1 ERP and related technologies, Business Intelligence, E-business and E-commerce, Business Process Reengineering,	04
03	**ERP and Implementation** 3.1 ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition , implementation methodology.	06
04	**ERP Business Modules** 4.1 Modules: Finance, manufacturing, human resources, quality management, material management, marketing. Sales distribution and service.	08
05	**Extended ERP** 5.1 Enterprise application Integration (EAI), open source ERP, cloud ERP.	04
Supply Chain Management (SCM)		
06	**Introduction and strategic decisions in SCM**	08

	6.1 Introduction to SCM, Generic Types of supply chain, Major Drivers of Supply chain, Strategic decisions in SCM, Business Strategy, CRM strategy, SRM strategy, SCOR model.	
07	**Information Technology in SCM** 7.1 Types of IT Solutions like Electronic Data Inter change (EDI), Intranet/ Extranet, Data Mining/ Data Warehousing and Data Marts, E-Commerce, E- Procurement, Bar coding, RFID, QR code.	06
08	**Mathematical modelling for SCM** 8.1 Introduction, Considerations in modelling SCM systems, Structuring the logistics chain, overview of models: models on transportation problem, assignment problem, vehicle routing problem, Model for vendor analysis, Make versus buy model.	06
09	**Agile Supply Chain** 9.1 Introduction, Characteristics of Agile Supply Chain, Achieving Agility in Supply Chain.	02
10	**Cases of Supply Chain** 10.1 Cases of Supply Chain like, News Paper Supply Chain, Book Publishing, Mumbai Dabbawala, Disaster management, Organic Food, Fast Food.	02

Term Work:

The distribution of marks for term work shall be as follows:

- Mini project:………………………………….………… (20) Marks.
- Attendance …………………………...……………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

The lab will be conducted on mini project which may be conducted on the following:

1) Simulating business processes of an Enterprise.
2) Designing a web portal for an Enterprise using E-business Models.
3) E-procurement model.
4) Open source ERP
5) Cloud ERP
6) Business process agility
7) SCM model.
8) Implementing Business Intelligence
9) Any other relevant topics covering the syllabus.

Text Books:

1. Enterprise Resource Planning : concepts & practices, by V.K. Garg & N.K. Venkatakrishnan ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. ERP Demystified: II Edition, by Alexis Leon,McGraw Hill .
4. Enterprise wide resource planning: Theory & practice: by Rahul Altekar,PHI.

Reference Books:

1. ERP to E^2 ERP: A Case study approach, by Sandeep Desai, Abhishek Srivastava, PHI.

2. Managerial Issues of ERP system, by David Olson, McGraw Hill.

Course Code	Course/Subject Name	Credits
CPE7022	**Computer Simulation and Modeling**	5

Course Objectives:

This course presents an introduction to discrete event simulation systems. Emphasis of the course will be on modeling and the use of simulation languages/software to solve real world problems in the manufacturing as well as services sectors. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly. The “theory” of simulation involves probability and statistics, thus a good background in probability and statistics is a required prerequisite

Course Outcomes:

1. Apply simulation concepts to achieve in business, science, engineering, industry and services goals
2. Demonstrate formulation and modeling skills.
3. Perform a simulation using spreadsheets as well as simulation language/package
4. Generate pseudorandom numbers using the Linear Congruential Method
5. Evaluate the quality of a pseudorandom number generator using statistical tests
6. Analyze and fit the collected data to different distributions

Module	Detailed Contents	Hours
	Computer Simulation and Modeling	
01	Introduction to Simulation. Simulation Examples. General Principles	15
02	Statistical Models in simulation. Queuing Models	08
03	Random Number Generation. Testing random numbers (Refer to Third edition) Random Variate Generation: Inverse transform technique, Direct Transformation for the Normal Distribution, Convolution Method, Acceptance-Rejection Technique (only Poisson Distribution).	09

04	Analysis of simulation data : Input Modeling ,Verification, Calibration and Validation of Simulation , Models , Estimation of absolute performance.	12
05	Application : Case study on 1. Processor and Memory simulation 2. Manufacturing & Material handling	04

Text Books:

Discrete Event System Simulation; Third Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

Discrete Event System Simulation; Fifth Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

References:

4. System Modeling & Analysis; Averill M Law, 4th Edition TMH.
5. Principles of Modeling and Simulation; Banks C M , Sokolowski J A; Wiley
6. System Simulation ; Geoffrey Gordon ; EEE
7. System Simulation with Digital Computer; Narsing Deo, PHI

Term work:

Laboratory work: 10 marks

Mini Simulation Project presentation: 10 marks

Attendance : 5 marks

Suggested Practical List (If Any):

Perform simulation exercises given in the text book (third edition) using spreadsheets and/or simulation language/package

5. Queue- single server, multi-server, classic case- dump truck
6. Inventory – Lead time=0, lead time fixed, lead time probabilistic
7. Reliability problem
8. Tutorials on statistical models
9. Random number generate and test
10. Goodness of fit test
11. Output analysis – Point estimate and Confidence Interval

Simulation: Real World Examples – can be in the field of business, transportation, medical, computing, manufacturing and material handling- Presentation to be taken.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Course Code	Course/Subject Name	Credits
CPL701	**Network threats and attacks Laboratory**	02

Outcomes: After completion of this Laboratory course learner will be able To

1. Use network-based tools for network analysis
2. Use techniques for Network scaning
3. Identify network vulnerability
4. Use tools to simulate intrusion detection system
5. To understand and install a firewall

Module	**Detailed Contents**
01	**1.1 Title:** Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars. **Objective:** Objective of this module to how to gather information about the networks by using different n/w reconnaissance tools. **Scope:** Network analysis using network based tools **Technology**: Networking
02	**2.1 Title:** Study of packet sniffer tools like wireshark, ethereal, tcpdump etc. You should be able to use the tools to do the following 1. Observer performance in promiscuous as well as non-promiscous mode. 2. Show that packets can be traced based on different filters. **Objective:** Objective of this module is to observer the performanance in promiscuous & non-promiscous mode & to find the packets based on different filters. **Scope:** Packet grapping, message and protocol analysis **Technology:** Networking
03	**3.1 Title:** Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc. **Objective:** objective of this module to learn nmap installation & use this to scan different ports. **Scope:** used for ip spoofing and port scanning **Technology**: Networking

04	**4.1 Title:** Detect ARP spoofing using open source tool ARPWATCH. **Objective:** Objective of the module to find ARP spoofing using open source. **Scope**: Ip spoofing using arp packaging tool **Technology:** Networking
05	**5.1 Title:** Use the Nessus tool to scan the network for vulnerabilities. **Objective:** Objective of the module is scan system and network analysis. **Scope:** It used for system analysis, security and process analysis **Technology:** Networking
06	**6.1 Title:** Implement a code to simulate buffer overflow attack. **Objective:** Objective of the module Is to check buffer overflow in an NS2 environment **Scope:** It uses to analyse memory overflow attack **Technology**: Networking
07	**7.1 Title:** Set up IPSEC under LINUX **Objective:** Objective of the module for implementing security vulnerabilities **Scope:** to study different ipsec tools. **Technology**: Networking
08	**8.1 Title:** Install IDS (e.g. SNORT) and study the logs. **Objective:** Simulate intrusion detection system using tools such as snort **Scope:** It is used for intrusion detection system vulnerability scans **Technology:** Networking
09	**9.1 Title:** Use of iptables in linux to create firewalls. **Objective:** To study how to create and destroy firewall security parameters. **Scope:** system security and network security **Technology**: Networking
10	**10.1 Title:** Mini project **Objective:** To implement Networking concepts

	Scope: To understand Network & system tools **Technology:** Networking

Term Work:

The distribution of marks for term work shall be as follows:

Lab Assignments:..	(10)	
Mini project:………………………………….…………	(10)	Marks.
Attendance ………………………...…………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Oral examination:

Oral examination is to be conducted by pair of internal and external examiners based on above syllabus and the mini projects done.

References:

1. Network Security Assessment by Chris McNab, O’Reilly
2. Network Security Hacks, Andrew Lockhart, O’Reilly
3. The Web Application Hacker’s Handbook 2nd Edition by Dafydd Stuttard & Marcus Pinto,Wiley Publication(2014).
4. Securing the Virtual Environment by Davi Ottenheimer & Matthew Wallace,Willey Publication(2012).

Course Code	Course/Subject Name	Credits
CPC801	**Data Warehousing and Mining**	5

Objectives:

1. To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

Outcomes: Learner will be able to…

1. Enable students to understand and implement classical algorithms in data mining and data warehousing; students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
2. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.

Module	**Detailed Contents**	**Hrs.**
01	**Introduction to Data Warehousing** 1.1 The Need for Data Warehousing; Increasing Demand for Strategic Information; Inability of Past Decision Support System; Operational V/s Decisional Support System; Data Warehouse Defined; Benefits of Data Warehousing ;Features of a Data Warehouse; The Information Flow Mechanism; Role of Metadata; Classification of Metadata; Data Warehouse Architecture; Different Types of Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies.	04
02	**Dimensional Modeling** 2.1 Data Warehouse Modeling Vs Operational Database Modeling; Dimensional Model Vs ER Model; Features of a Good Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; The Factless Fact Table; Updates To Dimension Tables: Slowly Changing Dimensions, Type 1 Changes, Type 2 Changes, Type 3 Changes, Large Dimension Tables, Rapidly Changing or Large Slowly Changing Dimensions, Junk Dimensions, Keys in the Data Warehouse Schema, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star.	06
03	**ETL Process** 3.1 Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Extracting Data: Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Data Loading: Techniques of Data Loading, Loading the Fact Tables and Dimension Tables Data Quality; Issues in Data Cleansing.	06
04	**Online Analytical Processing (OLAP)**	04

	4.1 Need for Online Analytical Processing; OLTP V/s OLAP; OLAP and Multidimensional Analysis; Hypercubes; OLAP Operations in Multidimensional Data Model; OLAP Models: MOLAP, ROLAP, HOLAP, DOLAP;	
05	**Introduction to data mining** 5.1 What is Data Mining; Knowledge Discovery in Database (KDD), What can be Data to be Mined, Related Concept to Data Mining, Data Mining Technique, Application and Issues in Data Mining	02
06	**Data Exploration** 6.1 Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.	02
07	**Data Preprocessing** 7.1 Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	04
08	**Classification** 8.1 Basic Concepts; **Classification methods:** 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes' Classifier. **8.2 Prediction**: Structure of regression models; Simple linear regression, Multiple linear regression. **8.3 Model Evaluation & Selection: A**ccuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap; Comparing Classifier performance using ROC Curves. **8.4 Combining Classifiers**: Bagging, Boosting, Random Forests.	06
09	**Clustering** 9.1 What is clustering? Types of data, Partitioning Methods (K-Means, K-Medoids) Hierarchical Methods(Agglomerative , Divisive, BRICH), Density-Based Methods (DBSCAN, OPTICS)	06
10	**Mining Frequent Pattern and Association Rule** 10.1 Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Mining closed and maximal patterns; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, Pattern Evaluation Measures; Introduction to Constraint-Based Association Mining.	08

Term Work:

Term work should consist of at least of the following:

1. One case study given to a group of 3 /4 students of a data mart/ data warehouse.
    a. Write Detail Statement Problem and creation of dimensional modeling (creation star and snowflake schema)
    b. Implementation of all dimension table and fact table
    c. Implementation of OLAP operations.
2. Implementation of classifier like Decision tree, Naïve Bayes, Random Forest using any languages like Java
3. Use WEKA to implement like Decision tree, Naïve Bayes, Random Forest
4. Implementation of clustering algorithm like K-means, K- Medoids, Agglomerative, Divisive using languages any like Java, C# , etc.
5. Use WEKA to implement the following Clustering Algorithms – K-means, Agglomerative, Divisive.
6. Implementation Association Mining like Apriori, FPM using languages like Java, C#, etc.
7. Use WEKA to implement Association Mining like Apriori, FPM.
8. Use R tool to implement Clustering/Association Rule/ Classification Algorithms.
9. Detailed study of any one BI tool like Oracle BI, SPSS, Clementine, and XLMiner etc. (paper Assignment)

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

An oral exam will be held based on the above syllabus

Text Books:

1) Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition

2) Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India
3) Reema Theraja “Data warehousing”, Oxford University Press.
4) M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education

Reference Books:

1) Randall Matignon, "Data Mining using SAS enterprise miner ", Wiley Student edition.
2) Alex Berson , S. J. Smith, “Data Warehousing, Data Mining & OLAP” , McGraw Hill.
3) Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4) Daniel Larose, “Data Mining Methods and Models”, Wiley India.

Course Code	Course/Subject Name	Credits
CPC802	**Human Machine Interaction**	5

Objectives:

1. To stress the importance of a good interface design.
2. To understand the importance of human psychology in designing good interfaces.
3. To motivate students to apply HMI in their day – to – day activities.
4. To bring out the creativity in each student – build innovative applications that are user friendly.
5. To encourage students to indulge into research in Machine Interface Design.

Outcomes: Learner will be able to…

1. To design user centric interfaces.
2. To design innovative and user friendly interfaces.
3. To apply HMI in their day-to-day activities.
4. To criticise existing interface designs, and improve them.
5. To Design application for social and technical task.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields. 1.2 The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error;	10
02	**Understanding goal directed design** 2.1 Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels; Understanding users; Modeling users – personas and goals.	08
03	**GUI** 3.1 benefits of a good UI; popularity of graphics; concept of direct manipulation; advantages and disadvantages; characteristics of GUI; characteristics of Web UI; General design principles.	08
04	**Design guidelines** 4.1 perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.	08
05	**Interaction styles** 5.1 menus; windows; device based controls, screen based controls;.	06
06	**Communication** 6.1 text messages; feedback and guidance; graphics, icons and images; colours.	08

Term Work:

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/case studies): ………….. (15) Marks.
- Assignment:…….……………………………………… (05) Marks.
- Attendance ……………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Laboratory:

Students are free to choose any tool that they feel appropriate for a given experiment. Each experiment will involve research about a certain category of people, and then developing an appropriate interface.

Students are expected to perform at least eight experiments from the given list.

LIST OF HMI PRACTICAL / EXPERIMENTS

1. Know your client –

   a. Children (4-5 years of age): An application to teach math.

   b. Teenagers: Design a digital diary for young teens to help them overcome various social pressures they deal with during their teen years. The diary should also be like a self help tool which would help them deal with incidents like bullying, peer pressure, etc.. This is an open project and you can think in any direction to make the children sail through their teen years while trying to discover life around them.

   c. Older generation: Folks from the older generation has been very wary of using their credit card on the Internet. They have various concerns when it comes to paying their bills. Also because of their old age, it will be beneficial for them to use the internet and pay their phone, electricity, gas, etc. bills

   d. Rural people: ATVM for train ticketing in rural area

2. Understand the trouble of interacting with machines - Redesign interfaces of home appliances like microwave oven, land-line phone, fully automatic washing machine.

3. Learn HCI design principles – heuristic evaluation: Identify 5 different websites catering to one specific goal (eg. Goal – on-line shopping and 5 different websites – ebay, amazon, flipkart, zovi, myntra) and perform a competitive analysis on them to understand how each one caters to the goal, the interactions and flow of the payment system and prepare a report on the same..

4. Learn the importance of menus and navigation – website redesign: News websites like CNN are always cluttered with information. It takes the user a few minutes to find his way through and maybe more minutes to look for some specific information. Redesign the news websites to make it look less cluttered, provide relevant information (a person sitting in Russia should not get US news as top news), intelligently dig information that he might be interested in based on his searches on the web.

5. Learn the importance of connecting humans – service design : How often have you found yourself waiting at the airport for a flight that is delayed or you've missed it and the next one is 4 hours from now, or waiting for a connecting flight? Design an experience for passengers to deal with the long waiting hours.

6. Learn the use of statistical graphics – expense tracker: Matt is a young engineer who just finished his summer internship at a leading Software Company in the United States. He has never been independent in handling his own finances and after this internship his father has asked him to start managing his money on his own. He is looking for a tool/app/software that would help him budget his finances, create goals and track them, categorize and track his credit card spending and also get insights on the various types of categories he's spending on. Design a tool/app/software that would help Matt manage his personal finances given the above requirement.

7. Learn the importance of graphics – way finding: Design a map for someone who is new to the city/town/village and is trying to understand how to commute from one place to another (inspired by New York Subway Maps, London Subway Maps)

8. Icon designing: Choose a unique domain, design a few icons and show how it can be accommodated on an interface.

9. Understand the need of colors and animation – web site for an artist: A celebrity in some form of art like music, dance, painting, martial arts, etc (not actors). This site will be used to display his works and should portray his character.

10. Understand the various input methods available for interaction – concept generation: Study the various technologies for typing – standard keyboards QWERTY, T9 (predictive text), multi-touch (SYWPE, etc.), gestures and brainstorm on the various ways in which you could improve one of the existing technologies. You could choose any of the different input types.

11. Any other new relevant topics covering the above syllabus.

Text Books:

1. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale “Human Computer Interaction”, Prentice Hall.
2. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
5. Donald A. Normann, “Design of everyday things”, Basic Books; Reprint edition 2002.

Reference Books:

1. Donald A. Norman, “The design of everyday things”, Basic books.
2. Rogers Sharp Preece, “Interaction Design:Beyond Human Computer Interaction”, Wiley.
3. Guy A. Boy “The Handbook of Human Machine Interaction”, Ashgate publishing Ltd.

Course Code	Course/Subject Name	Credits
CPC803	**Parallel and Distributed Systems**	5

Objectives:

1. To provide students with contemporary knowledge in parallel and distributed systems
2. To equip students with skills to analyze and design parallel and distributed applications.
3. To provide master skills to measure the performance of parallel and distributed algorithms

Outcomes: Learner will be able to…

1. Apply the principles and concept in analyzing and designing the parallel and distributed system
2. Reason about ways to parallelize problems.
3. Gain an appreciation on the challenges and opportunities faced by parallel and distributed systems.
4. Understand the middleware technologies that support distributed applications such as RPC, RMI and object based middleware.
5. Improve the performance and reliability of distributed and parallel programs.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Parallel Computing, Parallel Architecture, Architectural Classification Scheme, Performance of Parallel Computers, Performance Metrics for Processors, Parallel Programming Models, Parallel Algorithms.	06
02	**Pipeline Processing** 2.1 Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline Stage Design, Hazards, Dynamic Instruction Scheduling,	06
03	**Synchronous Parallel Processing** 3.1 Introduction, Example-SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and memory in array processors, Case studies of SIMD parallel Processors	06
04	**Introduction to Distributed Systems** 4.1 Definition, Issues, Goals, Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept, Models of Middleware, Services offered by middleware, Client Server model.	06
05	**Communication** 5.1 Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication	04
06	**Resource and Process Management** 6.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration	06
07	**Synchronization**	08

	7.1 Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure, Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala’s Algorithm, Maekawa’s Algorithm 7.2 Token Based Algorithms: Suzuki-Kasami’s Broardcast Algorithms, Singhal’s Heurastic Algorithm, Raymond’s Tree based Algorithm, Comparative Performance Analysis.	
08	**Consistency and Replication** 8.1 Introduction, Data-Centric and Client-Centric Consistency Models, Replica Management. **Distributed File Systems** 8.2 Introduction, good features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Network File System(NFS), Andrew File System(AFS), Hadoop Distributed File System and Map Reduce.	06

Term Work:

Term work should consist of at least 10 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

The distribution of marks for term work shall be as follows:
- Laboratory work (experiments): ……………………….. (15) Marks.
- Assignments: …………………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral Examination will be based on above syllabus

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Load Balancing Algorithm.
2. Scalability in Distributed Environment
3. Client/server using RPC/RMI.
4. Inter-process communication
5. Election Algorithm.
6. Distributed Deadlock.
7. Name Resolution protocol.
8. Clock Synchronization algorithms.
9. Mutual Exclusion Algorithm.
10. Group Communication.
11. CORBA architecture.
12. Parallel Algorithms.
13. Message Passing Interface.

Text Books

1. M.R. Bhujade, “Parallel Computing”, 2nd edition, New Age International Publishers 2009.
2. Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education, Inc., 2007, ISBN: 0-13-239227-5.

Reference Books

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design” (4th Edition), Addison Wesley/Pearson Education.
2. Pradeep K Sinha, “Distributed Operating Systems : Concepts and design”, IEEE computer society press

Course Code	Course/Subject Name	Credits
CPE8031	**Elective-III Machine Learning**	5

Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods, clustering methods.
3. To become familiar with support vector machine and Dimensionality reduction Techniques.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use Machine Learning Techniques.
2. Ability to understand regression, classification, clustering methods.
3. Ability to understand the difference between supervised and unsupervised learning methods.
4. Ability to appreciate Dimensionality reduction techniques.
5. Students would understand the working of Reinforcement learning.

Module	Detailed Contents	Hrs.
01	**Introduction to Machine Learning** 1.1 What is Machine Learning?, Key Terminology, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, How to choose the right algorithm, Steps in developing a Machine Learning Application.	06
02	**Learning with Regression** 2.1 Linear Regression, Logistic Regression.	04
03	**Learning with trees** 3.1 Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART).	08
04	**Support Vector Machines(SVM)** 4.1 Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	06
05	**Learning with Classification** 5.1 Rule based classification, classification by backpropoagation, Bayesian Belief networks, Hidden Markov Models.	06
06	**Dimensionality Reduction** 6.1 Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis.	06
07	**Learning with Clustering** 7.1 K-means clustering, Hierarchical clustering, Expectation Maximization	06

	Algorithm, Supervised learning after clustering, Radial Basis functions.	
08	**Reinforcement Learning** 8.1 Introduction, Elements of Reinforcement Learning, Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	06

Term Work:

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………..……………...	(15)	Marks.
• Assignments:………….………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

LIST OF ML PRACTICAL / EXPERIMENTS

1. To implement Linear Regression

2. To implement Logistic Regression

3. To implement ID3.

4. To implement Support Vector Machine.

5. To implement Bayesian Classification.

6. To implement K-Nearest Neighbour.

7. To implement k-means Clustering.

8. To implement Agglomerative Clustering.

Any other practical covering the syllabus topics and subtopics can be conducted.

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press

Reference Books:

1. William W.Hsieh, “Machine Learning Mehods in the Environmental Sciences”, Cambridge
2. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
3. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Course Code	Course/Subject Name	Credits
CPE8032	**Elective-III Embedded Systems**	5

Objectives:

1. Develop, among students, an understanding of the technologies behind the embedded computing systems; and to differentiate between such technologies.
2. Make aware of the capabilities and limitations of the various hardware or software components.
3. Evaluate design tradeoffs between different technology choices.
4. Complete or partial design of such embedded systems

Outcomes: Learner will be able to…

1. Describe the special requirements that are imposed on embedded systems
2. Describe the key properties of microprocessor and digital signal processor
3. Sketch a design of an embedded system around a microprocessor or DSP
4. Explain how microprocessor, memory, peripheral components and buses interact in an embedded system
5. Evaluate how architectural and implementation decisions influence performance and power dissipation
6. Produce efficient code for embedded systems
7. Point out the role of the compiler in the embedded system design process
8. Define the properties of a real-time operating system
9. Estimate the requirement for additional hardware for optimized performance
10. Understand and distinguish between the RISC and the Advanced RISC architecture
11. Utilize embedded systems to perform operations such as signal processing in real time
12. Develop drivers for external peripheral devices as per requirement.

Module	Detailed Contents	Hrs.
01	**Introduction to computational technologies** 1.1 Review of computation technologies (ARM, RISC, CISC, PLD, SOC), architecture, event managers, hardware multipliers, pipelining. Hardware/Software co-design. Embedded systems architecture and design process.	08
02	**Program Design and Analysis** 2.1 Integrated Development Environment (IDE), assembler, linking and loading. Program-level performance analysis and optimization, energy and power analysis and program size optimization, program validation and testing. Embedded Linux, kernel architecture, GNU cross platform tool chain. Programming with Linux environment.	08
03	**Process Models and Product development life cycle management** 3.1 State machine models: finite-state machines (FSM), finite-state machines with data-path model (FSMD), hierarchical/concurrent state machine	08

	model (HCFSM), program-state machine model (PSM), concurrent process model. Unified Modeling Language (UML), applications of UML in embedded systems. IP-cores, design process model. Hardware software co-design, embedded product development life cycle management.	
04	**High Performance 32-bit RISC Architecture** 4.1 ARM processor family, ARM architecture, instruction set, addressing modes, operating modes, interrupt structure, and internal peripherals. ARM coprocessors, ARM Cortex-M3.	08
05	**Processes and Operating Systems** 5.1 Introduction to Embedded Operating System, multiple tasks and multiple processes. Multi rate systems, preemptive real-time operating systems, priority-based scheduling, inter-process communication mechanisms. Operating system performance and optimization strategies. Examples of real-time operating systems.	08
06	**Real-time Digital Signal Processing (DSP)** 6.1 Introduction to Real-time simulation, numerical solution of the mathematical model of physical system. DSP on ARM, SIMD techniques. Correlation, Convolution, DFT, FIR filter and IIR Filter implementation on ARM. Open Multimedia Applications Platform (OMAP)	08

Term Work:

Term work should consist of at least 10 practicals and one mini project. Objective type term work test shall be conducted with a weightage of 10 marks.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments/projects): …….….…..	(10)	Marks.
• Mini project: ……………………………………………	(10)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

The final certification and acceptance of Term Work ensures the satisfactory performance of laboratory work and minimum passing in term work.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

List of Experiments:

Topic-1: Troubleshooting Tools [Any One]

In-Circuit Emulator (ICE) and In-Circuit Debugger (ICD), Logic Analyzer, Spectrum Analyzer, Pattern generator and Digital Storage Oscilloscope.

Topic -2: ARM Processors & Interfaces [Any Four]

LEDs and Keyboard Interface, LCD Interface, Counting external events with on chip counters, Real Time Clock (RTC), Pulse Width Modulation (PWM), Relay and Buzzer Control for alarm events, Stepper Motor Control , On chip ADC/DAC SPI / I2C / UART Interface, Bluetooth/Zig-bee interface.

Topic-3: Real-time Signal Processing ARM-DSP [Any Two]

Real-time physical model simulation, Correlation, convolution, DFT, FIR or IIR design, Real-time DAS and GUI using PC and ARM, Design with Programmable Logic Devices (CPLD/FPGA).

Topic-4: Device Driver Development [Any One]

Drivers for CAN, Drivers for USB, Drivers for Ethernet, SVGA, Drivers for Graphics TFT LCD.

Topic-5: Real Time Operating System (RTOS) [Any Two]

RTLinux , MicroC/OS_II, VxWorks, WIN CE, QNX, Palm OS, Symbian OS, Android OS or equivalent OS.

Text Books:

1. Embedded Systems an Integrated Approach – Lyla B Das, Pearson
2. Computers as Components – Marilyn Wolf, Third Edition Elsevier
3. Embedded Systems Design: A Unified Hardware/Software Introduction – Frank Vahid and Tony Givargis, John Wiley & Sons
4. An Embedded Software Primer – David E. Simon – Pearson Education Sough Asia
5. ARM System Developer’s Guide Designing and Optimizing System Software – Andrew N. Sloss, Dominic Sysmes and Chris Wright – Elsevier Inc.

Reference Books:

1. Embedded Systems, Architecture, Programming and Design – Raj Kamal – Tata McGraw Hill
2. Embedded Linux – Hollabaugh, Pearson Education

3. Embedded Realtime Systems Programming – Sriram V Iyer, Pankaj Gupta – Tata McGRaw Hill.
4. Fundamentals of Microcontrollers and Applications in Embedded Systems – Ramesh Gaonkar – Penram International Publishing (India) Pvt. Ltd.
5. Embedded / Real-Time Systems: Concepts, Design & Programming – Dr. K. V. K. K. Prasad – Dreamtech Press, India.

Course Code	Course/Subject Name	Credits
CPE8033	**Elective-III Adhoc Wireless Networks**	5

Objectives:

1. To Identify the major issues associated with ad-hoc networks
2. To identify the requirements for protocols for wireless ad-hoc networks as compared to the protocols existing for wired network.
3. To explore current ad-hoc technologies by researching key areas such as algorithms, protocols, hardware, and applications.
4. To Provide hands-on experience through real-world programming projects
5. To provide advanced in –depth networking materials to graduate students in networking research.

Outcomes: Learner will be able to…

1. Define characteristics and features of Adhoc Networks
2. Appreciate the designing of MAC protocol for Adhoc networks
3. Implement few protocols
4. Apply security principles for routing

Module	**Detailed Contents**	**Hrs.**
01	**Introduction** 1.1 Introduction to wireless Networks. Characteristics of Wireless channel, Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models. 1.2 Adhoc Networks: Introduction to adhoc networks – definition, characteristics features, applications.	04
02	**MAC Layer** 2.1 MAC Protocols for Ad hoc wireless Networks: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals and Classification of a MAC protocol, Contention based protocols with reservation mechanisms. 2.2 Scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, 802.16, HIPERLAN.	10
03	**Network Layer** 3.1 Routing protocols for Ad hoc wireless Networks: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table driven routing protocol, On-demand routing protocol. 3.2 Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.	10
04	**Transport Layer** 4.1 Transport layer protocols for Ad hoc wireless Networks: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless	07

	Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks, Other transport layer protocols for Ad hoc wireless Networks.	
05	**Security** 5.1 Security: Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning, Network security attacks, Key management, Secure routing in Ad hoc wireless Networks.	07
06	**QoS** 6.1 Quality of service in Ad hoc wireless Networks: Introduction, Issues and challenges in providing QoS in Ad hoc wireless Networks, Classification of QoS solutions, MAC layer solutions, network layer solutions.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………….………..	(15)	Marks.
• Assignment:…………….………………………………	(05)	Marks.
• Attendance ……………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

oral examination based on above syllabus will be conducted

Suggested Practicals for Adhoc Wireless

1. Installation of NS2 in Ubuntu 12.04 Linux.
2. Build and exchange data in simple infrastructure and Adhoc network by using personal computer and Android based mobile.
3. Develop sample wireless network in which

    a. implement AODV and AOMDV protocol

    b. Calculate the time to receive reply from the receiver using NS2.
    c. Generate graphs which show the transmission time for packet.

4. Implement wireless network. Capture data frame and identify fields using NS2.
5. Configure Wireless Access Point (WAP) and build different networks.
6. Implement Mobile device as a wireless access point.
7. Communicate between two different networks which has following specifications:
    a. One network has Class A network with “Tora protocol”
    b. Second has Class B network “AODV protocol”

Practical exam will be based on the above syllabus.

Text Books:

1. Siva Ram Murthy and B.S.Manoj, “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education, 2007
2. Charles E. Perkins, “Adhoc Networking”, Addison – Wesley, 2000
3. C. K. Toh,”Adhoc Mobile Wireless Networks”, Pearson Education, 2002

Reference Books:

1. Matthew Gast, “802.11 Wireless Networks: The Definitive Guide”, 2nd Edition, O'Reilly Media, April 2005.
2. Stefano Basagni, Marco Conti, Silvia Giordan and Ivan Stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE Press, 2004.
3. Mohammad Ilyas, “The handbook of Adhoc Wireless Networks”, CRC Press, 2002

Course Code	Course/Subject Name	Credits
CPE8034	**Elective-III Digital Forensics**	5

Objectives:

1. To focus on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence.
2. To provide hands on experience on various forensic tools and resources for system administrators and information system security officers.

Module	**Detailed Contents**	**Hrs.**
01	**Introduction:** 1.1 Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	09
02	**Initial Response and forensic duplication** 2.1 Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic. 2.2 Duplicate/Qualified Forensic Duplicate of a Hard Drive.	08
03	**Preserving and Recovering Digital Evidence** 3.1 File Systems: FAT, NTFS - Forensic Analysis of File Systems - Storage Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.	09
04	**Network Forensics** 4.1 Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud.	07
05	**System investigation** 5.1 Data Analysis Techniques - Investigating Live Systems (Windows & Unix) Investigating 5.2 Hacker Tools - Ethical Issues – Cybercrime.	08
06	**Bodies of law** 6.1 Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws , Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof : Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.	07

Term Work:

- Term work should consist of at least 12 experiments.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

• Laboratory work (experiments): ………………………..	(15)	Marks.
• Assignment: ……………………………………………	(05)	Marks.
• Attendance …………………………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

Oral exam will be based on the above syllabus.

Text Books:

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References:

1. Skoudis. E., Perlman. R. Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses.Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000
3. Bill Nelson, Amelia Philips and Christopher Steuart, "Guide to computer forensics investigation "Course technology, 4th edition

Course Code	Course/Subject Name	Credits
CPE8035	**Elective III - Big Data Analytics**	5

Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Outcomes: Learner will be able to…

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Module	Detailed Contents	Hrs.
01	**Introduction to Big Data** 1.1 Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	03
02	**Introduction to Hadoop** 2.1 What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Physical Architecture; Hadoop limitations.	03
03	**NoSQL** 3.1 What is NoSQL? NoSQL business drivers; NoSQL case studies; 3.2 NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns; 3.3 Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	04
04	**MapReduce and the New Software Stack** **4.1 Distributed File Systems :** Physical Organization of Compute Nodes, Large-Scale File-System Organization. **4.2 MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks,	06

	Combiners, Details of MapReduce Execution, Coping With Node Failures. **4.3 Algorithms Using MapReduce**: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	
05	**Finding Similar Items** 5.1 Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem . 5.2 **Distance Measures:** Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	03
06	**Mining Data Streams** **6.1 The Stream Data Model**: A Data-Stream-Management System, Examples of Stream Sources, Stream Querie, Issues in Stream Processing. **6.2 Sampling Data in a Stream** : Obtaining a Representative Sample , The General Sampling Problem, Varying the Sample Size. **6.3 Filtering Streams**: The Bloom Filter, Analysis. **6.4 Counting Distinct Elements in a Stream** The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . **6.5 Counting Ones in a Window**: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	06
07	**Link Analysis** 7.1 PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 7.2 Topic sensitive Page Rank, link Spam, Hubs and Authorities.	05
08	**Frequent Itemsets** **8.1 Handling Larger Datasets in Main Memory** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multihash Algorithm. **8.2 The SON Algorithm and MapReduce** **8.3 Counting Frequent Items in a Stream** Sampling Methods for Streams, Frequent Itemsets in Decaying Windows	05
09	**Clustering** 9.1 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries	05

10	**Recommendation Systems** 10.1 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	04
11	**Mining Social-Network Graphs** 11.1 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, SimRank, Counting triangles using Map-Reduce	04

Term Work:

Assign a case study for group of 2/3 students and each group to perform the following experiments on their case-study; Each group should perform the exercises on a large dataset created by them.

The distribution of marks for term work shall be as follows:

- Programming Exercises: ………………………..….. (10) Marks.
- Mini project: ………………………………………… (10) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

An oral exam will be held based on the above syllabus.

Suggested Practical List: Students will perform at least 8 programming exercises and implement one mini-project. The students can work in groups of 2/3.

1. Study of Hadoop ecosystem
2. programming exercises on Hadoop
3. programming exercises in No SQL
4. Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication, Aggregates, joins, sorting, searching etc.
5. Implementing any one Frequent Itemset algorithm using Map-Reduce
6. Implementing any one Clustering algorithm using Map-Reduce
7. Implementing any one data streaming algorithm using Map-Reduce
8. Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web)

a. Twitter data analysis
b. Fraud Detection
c. Text Mining etc.

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks **, "**Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
2. Chuck Lam, "Hadoop in Action", Dreamtech Press

Course Code	Course/Subject Name	Credits
CPL801	**Cloud Computing Laboratory**	1

Outcomes: Learner will be able to…

1. Appreciate cloud architecture
2. Create and run virtual machines on open source OS
3. implement Infrastructure , storage as a Service**.**
4. Install and appreciate security features for cloud

Module	Detailed Contents	Lab Session
01	**Title:** Study of Cloud Computing & Architecture. **Concept:** Cloud Computing & Architecture. **Objective:** Objective of this module is to provide students an overview of the Cloud Computing and Architecture and different types of Cloud Computing **Scope:** Cloud Computing & Architecture Types of Cloud Computing . **Technology: ---**	**01**
02	**Title:** Virtualization in Cloud. **Concept:** Virtualization **Objective:** In this module students will learn, Virtualization Basics, Objectives of Virtualization, and Benefits of Virtualization in cloud. **Scope:** Creating and running virtual machines on open source OS. **Technology:** KVM, VMware.	**02**
03	**Title:** Study and implementation of Infrastructure as a Service . **Concept:** Infrastructure as a Service**.** **Objective:** In this module student will learn Infrastructure as a Service and implement it by using OpenStack. **Scope:** Installing OpenStack and use it as Infrastructure as a Service . **Technology:** Quanta Plus /Aptana /Kompozer	**02**
04	**Title:** Study and installation of Storage as Service.	**02**

	Concept: Storage as Service (SaaS) **Objective:** is that, students must be able to understand the concept of SaaS , and how it is implemented using ownCloud which gives universal access to files through a web interface. **Scope:** is to installation and understanding features of ownCloud as SaaS**.** **Technology:** ownCloud	
05	**Title:** Implementation of identity management. **Concept:** Identity Management in cloud **Objective:** this lab gives an introduction about identity management in cloud and simulate it by using OpenStack **Scope:** installing and using identity management feature of OpenStack **Technology:** OpenStack	**02**
06	**Title:** Write a program for web feed. **Concept:** Web feed and RSS **Objective:** this lab is to understand the concept of form and control validation **Scope:** Write a program for web feed **Technology:** PHP, HTML	**02**
07	**Title:** Study and implementation of Single-Sing-On. **Concept:** Single Sing On (SSO),openID **Objective:** is to understand the concept of access control in cloud and single sing on (SSO), Use SSO and advantages of it, and also students should able to implementation of it. **Scope:** installing and using JOSSO **Technology:** JOSSO	**02**
08	**Title:** Securing Servers in Cloud. **Concept:** Cloud Security **Objective:** is to understand how to secure web server, how to secure data directory and introduction to encryption for own cloud.	**02**

	Scope: Installing and using security feature of ownCloud **Technology:** ownCloud	
09	**Title:** User Management in Cloud. **Concept:** Administrative features of Cloud Managenet ,User Management **Objective:** is to understand how to create, manage user and group of users accounts. **Scope:** Installing and using Administrative features of ownCloud **Technology:** ownCloud	**02**
10	**Title:** Case study on Amazon EC2. **Concept:** Amazon EC2 **Objective:** in this module students will learn about Amazon EC2. Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. EC2 allows users to rent virtual computers on which to run their own computer applications	**01**
11	**Title:** Case study on Microsoft azure. **Concept:** Microsoft Azure **Objective:** students will learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. **Technology:** Microsoft azure	**01**
12	**Title:** Mini project. **Concept:** using different features of cloud computing creating own cloud for institute, organization etc. **Objective:** is student must be able to create own cloud using different features which are learned in previous practices. **Scope:** creating a cloud like social site for institute. **Technology:** any open system used for cloud	**05**

Term Work:

- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ……………………….. (15) Marks.
- Mini project presentation: ………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: …………………………………………… (25) Marks.

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 , ISBN:978-0-470-58987-8
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013
4. www.openstack.org

Course Code	Course/Subject Name	Credits
CP701 / CP802	**Project I/ II**	**3 / 6**

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions

AC – 11.05.2017

Item No. 4.193

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Third Year with Effect from **AY 2018-19**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO‟s) and give freedom to affiliated Institutes to add few (PEO‟s). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner‟s learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner‟s performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman’s Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To equip the Learner with broad education necessary to understand the impact of Computer Science and Engineering in a global and social context.
4. To encourage, motivate and prepare the Learner‟s for Lifelong- learning.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner‟s thought process.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner‟s point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. Subhash K. Shinde
Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1		1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	**20**	**14**	-	**20**	**7**	-	**27**

@ 1 hour to be taken tutorial as class wise.

*2 hours shown as Practical‟s to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
Total		100	100	100	400	-	150	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract**	**Tut**	**Theory**	**TW/ Pract**	**Tut**	**Total**
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Complier Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
	Total	**20**	**12**	-	**20**	**6**	-	**26**

Course Code	**Course Name**	**Examination Scheme**								
		Theory					**TW**	**Oral**	**Oral & Pract**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam Duration (in Hrs)**				
		Test 1	**Test 2**	**Avg.**						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Complier Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
	Total	100	100	100	400	-	150	25	100	750

Course Code	Course Name	Credits
CSC501	**Microprocessor**	**4**

Course objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
2. To emphasize on instruction set and logic to build assembly language programs.
3. To prepare students for higher processor architectures and Embedded systems

Course outcomes: On successful completion of course learner will be able to:

1. Describe architecture of x86 processors.
2. Interpret the instructions of 8086 and write assembly and Mixed language programs.
3. Explain the concept of interrupts
4. Identify the specifications of peripheral chip
5. Design 8086 based system using memory and peripheral chips
6. Appraise the architecture of advanced processors

Prerequisite: Digital Electronics and Logic Design

Module No.	Unit No.	Topics	Hrs.
1.0		**The Intel Microprocessors 8086/8088 Architecture**	**10**
	1.1	• 8086/8088 CPU Architecture, Programmer‘s Model • Functional Pin Diagram • Memory Segmentation • Banking in 8086 • Demultiplexing of Address/Data bus • Study of 8284 Clock Generator • Study of 8288 Bus Controller • Functioning of 8086 in Minimum mode and Maximum mode • Timing diagrams for Read and Write operations in minimum and maximum mode	
2.0		**Instruction Set and Programming**	**12**
	2.1	• Addressing Modes • Instruction set – Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions • Assembler Directives and Assembly Language Programming, Macros, Procedures • Mixed Language Programming with C Language and Assembly Language. • Programming based on DOS and BIOS Interrupts (INT 21H, INT 10H)	
3.0		**8086 Interrupts**	**6**
	3.1	• Types of interrupts • Interrupt Service Routine • Interrupt Vector Table • Servicing of Interrupts by 8086 microprocessor • Programmable Interrupt Controller 8259 – Block Diagram, Interfacing the 8259 in single and cascaded mode, Operating modes, programs for 8259 using ICWs and OCWs	

4.0		**Peripherals and their interfacing with 8086**	**12**
	4.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	4.2	8255-PPI – Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.3	8253 PIT - Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.4	8257-DMAC – Block diagram, Functional PIN Diagram, Register organization, DMA operations and transfer modes	
5.0		**Intel 80386DX Processor**	**6**
	5.1	• Architecture of 80386 microprocessor • 80386 registers – General purpose Registers, EFLAGS and Control registers • Real mode, Protected mode, virtual 8086 mode • 80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
6.0		**Pentium Processor**	**6**
	6.1	Pentium Architecture Superscalar Operation, Integer & Floating Point Pipeline Stages, Branch Prediction Logic, Cache Organisation and MESI Model	
		Total	**52**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
1. The students need to solve total 4 questions.
2. Question No.1 will be compulsory and based on entire syllabus.
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. 8086/8088 family: Design Programming and Interfacing: John Uffenbeck , PHI.
2. Advanced Microprocessors and Peripherals: K M Bhurchandani, A k Ray McGraw Hill
3. The 80386DX Microprocessor: hardware, Software and Interfacing, Walter A Triebel, Prentice Hall
4. Pentium Processor System Architecture: Tom Shanley & Don Anderson, Addison-Wesley.

Reference Books:

1. Intel Microprocessors: Barry B. Brey, 8th Edition, Pearson Education India
2. Microprocessor and Interfacing: Douglas Hall, Tata McGraw Hill.
3. Advanced MS DOS Programming – Ray Duncan BPB
4. Intel 80386 Datasheets
5. IBM PC Assembly language and Programming: Peter Abel, 5th edition, PHI
6. The Pentium Microprocessor, James Antonakons, Pearson Education

Course Code	Course Name	Credits
CSC502	**Database Management System**	**4**

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Prerequisite:

Basic knowledge of Data structure.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction Database Concepts:**	**4**
	1.1	● Introduction, Characteristics of databases ● File system v/s Database system ● Users of Database system	
	1.2	● Data Independence ● DBMS system architecture ● Database Administrator	
2.0		**Entity–Relationship Data Model**	**8**
	2.1	● The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation	
3.0		**Relational Model and relational Algebra**	**8**
	3.1	● Introduction to the Relational Model, relational schema and concept of keys. ● Mapping the ER and EER Model to the Relational Model	
	3.2	● Relational Algebra – unary and set operations, Relational Algebra Queries.	
4.0		**Structured Query Language (SQL)**	**12**
	4.1	● Overview of SQL	

		● Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	
	4.2	● Set and string operations, aggregate function - group by, having. ● Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints	
	4.3	● Triggers	
5.0		**Relational–Database Design**	**8**
	5.1	● Pitfalls in Relational-Database designs , Concept of normalization ● Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF.	
6.0		**Transactions Management and Concurrency**	**12**
	6.1	● Transaction concept, Transaction states, ACID properties ● Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	
	6.2	● Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. ● Deadlock handling	
		Total	**52**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. G. K. Gupta —Database Management Systems‖, McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, —Database System Concepts‖, 6th Edition, McGraw – Hill
3. Elmasri and Navathe, —Fundamentals of Database Systems‖, 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, —Database Systems Design, Implementation and Management‖, Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, —Introduction to Database Management‖, Wiley Publication.
3. Sharaman Shah, —Oracle for Professional‖, SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, — Database Management Systems ‖,TMH.

Course Code	Course Name	Credits
CSC 503	**Computer Network**	**4**

Course objective:

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand the transport layer and various application layer protocols.

Course Outcomes:

On successful completion of course learner will be able to:

1. Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2. Demonstrate the knowledge of networking protocols at data link layer.
3. Design the network using IP addressing and subnetting / supernetting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer .

Prerequisite: Digital Communication Fundamentals

Module No.	Unit No.	Topics	Hrs.
1	**Introduction to Networking**		06
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layer.	
2	**Physical Layer**		06
	2.1	Introduction to Communication System, digital Communication, Electromagnetic Spectrum	
	2.2	**Guided Transmission Media:** Twisted pair, Coaxial, Fiber optics. Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	

3	**Data Link Layer**		10
	3.1	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC	
	3.2	**Medium Access Control sublayer** Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3)	
4	**Network layer**		14
	4.1	4.1 Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT)	
	4.2	**Routing algorithms :** Shortest Path (Dijkastra‘s), Link state routing, Distance Vector Routing	
	4.3	**Protocols** - ARP,RARP, ICMP, IGMP	
	4.4	**Congestion control algorithms:** Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5	**Transport Layer**		10
	5.1	**The Transport Service**: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6	**Application Layer**		06
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Textbooks:

1. A.S. Tanenbaum, ―Computer Networks‖, Pearson Education, (4e)
2. B.A. Forouzan, ―Data Communications and Networking‖, TMH (5e)
3. James F. Kurose, Keith W. Ross, ―Computer Networking, A Top-Down Approach Featuring the Internet‖, Addison Wesley, (6e)

References:

1. S.Keshav: An Engineering Approach To Computer Networking, Pearson
2. Natalia Olifer& Victor Olifer,―Computer Networks:Principles, Technologies & Protocols for Network Design‖, Wiley India, 2011.
3. Larry L.Peterson, Bruce S.Davie, Computer Networks: A Systems Approach, Second Edition (The Morgan Kaufmann Series in Networking).

Course Code	Course Name	Credits
CSC504	**Theory of Computer Science**	4

Course Objectives:

1. Acquire conceptual understanding of fundamentals of grammars and languages.
2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3. Develop understanding of different types of Turing machines and applications.
4. Understand the concept of Undecidability.

Course Outcomes: On successful completion of course learner will be able to:

1. Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.
2. Infer the equivalence of languages described by finite automata and regular expressions.
3. Devise regular, context free grammars while recognizing the strings and tokens.
4. Design pushdown automata to recognize the language.
5. Develop an understanding of computation through Turing Machine.
6. Acquire fundamental understanding of decidability and undecidability.

Prerequisite: Discrete Mathematics

Module No.	Unit No.	Topics	Theory Hrs.	Tutorial Hrs.
1.0		**Basic Concepts and Finite Automata**	09	03
	1.1	• Alphabets, Strings, Languages, Closure properties. • Finite Automata (FA) and Finite State machine (FSM).		
	1.2	• Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers • NFA to DFA Conversion • Equivalence between NFA with and without ε- transitions • Minimization of DFA • FSM with output: Moore and Mealy machines, Equivalence • Applications and limitations of FA		
2.0		**Regular Expressions and Languages**	06	02
	2.1	• Regular Expression (RE) • Equivalence of RE and FA, Arden‘s Theorem • RE Applications		
	2.2	• Regular Language (RL) • Closure properties of RLs • Decision properties of RLs • Pumping lemma for RLs		
3.0		**Grammars**	08	03
	3.1	• Grammars and Chomsky hierarchy		
	3.2	• Regular Grammar (RG)		

		• Equivalence of Left and Right linear grammar • Equivalence of RG and FA		
	3.3	**Context Free Grammars (CFG)** • Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity. • Simplification and Applications. • Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF). • CFLs - Pumping lemma, Closure properties		
4.0		**Pushdown Automata(PDA)**	**04**	**01**
	4.1	• Definition, Transitions ,Language of PDA • Language acceptance by final state and empty stack • PDA as generator, decider and acceptor of CFG. • Deterministic PDA , Non-Deterministic PDA • Application of PDA.		
5.0		**Turing Machine (TM)**	**09**	**03**
	5.1	• Definition, Transitions • Design of TM as generator, decider and acceptor. • Variants of TM: Multitrack, Multitape • Universal TM. • Equivalence of Single and Multi Tape TMs. • Applications, Power and Limitations of TMs. • Context Sensitivity and Linear Bound Automata.		
6.0		**Undecidability**	**03**	**01**
	6.1	• Decidability and Undecidability, • Recursive and Recursively Enumerable Languages. • Halting Problem, • Rice‘s Theorem, • Post Correspondence Problem,		
		Total	**39**	**13**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, ―Introduction to Automata Theory, Languages andComputation‖, Pearson Education.
2. Michael Sipser, ―Theory of Computation‖, Cengage learning.
3. Vivek Kulkarni, ―Theory of Computation‖, Oxford University Press, India.

Reference Books:

1. J. C. Martin, ―Introduction to Languages and the Theory of Computation‖, Tata McGraw Hill.
2. Kavi Mahesh, ―Theory of Computation: A Problem Solving Approach‖, Wiley-India.

Course Code	Course Name	Credits
CSDLO5011	**Multimedia System**	**4**

Course objectives:

1. To introduce students about basic fundamentals and key aspects of Multimedia system.
2. To provide knowledge of compression techniques of different multimedia components
3. To help students to understand multimedia communication standards along with technology environment
4. To provide an opportunity to gain hands-on experience in building multimedia applications.

Course outcomes: Learner will be able to

1. To identify basics of multimedia and multimedia system architecture.
2. To understand different multimedia components.
3. To explain file formats for different multimedia components.
4. To analyze the different compression algorithms.
5. To describe various multimedia communication techniques.
6. To apply different security techniques in multimedia environment.

Prerequisite: Computer Fundaments and Graphics.

Module No.	**Unit No.**	**Topics**	**Hrs.**
1	**Introduction to Multimedia**		8
	1.1	Overview	
	1.2	Objects and Elements of Multimedia	
	1.3	Applications of Multimedia	
	1.4	Multimedia Systems Architecture – IMA, Workstation, Network	
	1.5	Types of Medium (Perception, Representation-..)	
	1.6	Interaction Techniques	
	1.7	I/O devices - Salient features (Electronic Pen , Scanner, Digital Camera, Printers, plotters), Storage Media (Jukebox, DVD), Multimedia Databases	
2	**Text & Digital Image**		10
	Text		
	2.1	Visual Representation, Digital Representation.	
	2.2	File Formats: RTF, TIFF.	
	2.3	Compression Techniques : Huffman Coding, RLE, CCITT group 3 1D	

	Digital Image		
	2.4	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), examples of images (X-Ray, fractal, synthetic, acoustic).	
	2.5	File formats: BMP, JPG	
	2.6	Compression Techniques: fundamentals (coding, interpixel and psychovisual redundancies),Types – lossless and lossy, Lossless Compression Algorithms– Shannon-Fano, CCITT group 4 2D, Lossy Compression Algorithm – JPEG	
3	**Digital Audio**		8
	3.1	Basic Sound Concepts: computer representation of sound,	
	3.2	File Formats – WAV, MPEG Audio	
	3.3	Compression: PCM, DM, DPCM	
4	**Digital Video**		8
	4.1	Digitization of Video, types of video signals (component, composite and S-video),	
	4.2	File Formats: MPEG Video, H.261	
	4.3	Compression: MPEG	
5	**Multimedia Network Communication and Representation**		10
	5.1	Quality of Service	
	5.2	Multimedia over IP (RTP, RTSP, RTCP,RSVP)	
	5.3	Representation- Authoring systems and user interface	
6	**Multimedia Security**		8
	6.1	Requirements and properties	
	6.2	Mechanisms – Digital Signatures, Steganographic methods	
	6.3	Sample applications – unidirectional distributed systems, information systems and conference systems	
		Total	**52**

Text Books:

1. Multimedia System Design, Prabhat K. Andleigh& Kiran Thakrar, PHI.
2. Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic&Dragorad A. Milovanovic, TMH.
3. Multimedia Systems, K. Buford, PHI.
4. Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

Reference Books:

1. Multimedia Computing Communications & Applications, Ralf Steinmetz & Klara Nahrstedt, Pearson.
2. Digital Image processing, Rafael C. Gonzalez, Richard E. Woods, Pearson.
3. Multimedia Applications, Ralf Steinmetz & Klara Nahrstedt, Springer International Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested List of Experiments:

1. Create a new file format to store a multimedia data.
2. Implement a compression technique and check the efficiency on different inputs.
3. To develop a theme based multimedia presentation
4. To add a digital signature onto a document
5. To perform steganography of text onto an image and check the efficiency with different inputs.

** Perform laboratory work of this course in _CSL504: Web Design Lab‘ as experiments or mini project.

Course Code	Course Name	Credits
CSDLO5012	**Advanced Operating Systems**	4

Course Objectives:

1. To understand design issues of Advanced Operating systems.
2. To understand the architecture, kernel and file management of Unix operating system.
3. To understand basic concepts and need of Distributed operating systems.
4. To understand concepts and working of different advanced Operating systems like Multiprocessor OS, Real time OS, Mobile OS.

Course Outcomes: On successful completion of the course student should be able to

1. Demonstrate understanding of design issues of Advanced operating systems and compare different types of operating systems.
2. Analyse design aspects and data structures used for file subsystem, memory subsystem and process subsystem of Unix OS.
3. Demonstrate understanding of different architectures used in Multiprocessor OS and analyse the design and data structures used in Multiprocessor operating systems.
4. Differentiate between threads and processes and compare different processor scheduling algorithms used in Multiprocessor OS
5. Classify Real Time OS and analyse various real time scheduling algorithms.
6. Explore architectures and design issues of Mobile OS,Virtual OS, Cloud OS.

Prerequisite: Operating Systems

Module	**Unit**	**Detailed Content**	Hrs
1		Introduction	04
		Functions of operating systems, Design approaches: layered, kernel based and virtual machine approach, types of advanced operating systems (NOS, DOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS)	
2		Unix Kernel and File Management	14
	2.1	System Structure, User Perspective, Architecture of Unix Operating System	
	2.2	Buffer cache: Header, Buffer Pool, Retrieving, Reading and Writing Buffer	
	2.3	File Representation: inodes: Structure of file Directories, Path conversion to inode, superblock, inode assignment, allocation of disk blocks	
3		Unix Process and Memory management	12
	3.1	Detailed design of Process Structure: Kernel Data structures for process, Structure of Uarea and Process table, Process states and Transitions	
	3.2	Context of a Process: Static and Dynamic area of context, Saving the Context Layout of System Memory, Regions, Mapping regions	

		with Process, page table and mapping virtual address to physical address.	
4		Distributed Operating system concepts	06
		Goals, Distributed Computing Models, Hardware Concepts, Software Concepts, Architecture of DOS. Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, fault tolerance	
5		Multiprocessor Operating System	08
	5.1	Introduction, Basic multiprocessor system architectures, design issues, Threads, Process synchronization: the test and set instruction, the swap instruction, implementation of the process wait	
	5.2	Processor scheduling: Issues, Co-scheduling, Smart scheduling, Affinity Based scheduling	
6		Real Time Operating Systems and Mobile OS	08
	6.1	Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Scheduling in RTOS: Clock driven: cyclic, Event driven: EDF and rate monotonic scheduling.	
	6.2	Mobile OS: Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design issues	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. The Design of the UNIX Operating System, PHI, by Maurice J. Bach.
2. Distributed Computing 2nd Edition, Mahajan and Seema Shah, OXford.
3. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjan G Shivaratri.
4. Mobile Computing by Rajkamal, 1st edition, Oxford.
5. Real Time Operating System, Jane W.S. Liu, Pearson.

Reference Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, ―Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. ―Real-Time Systems: Theory and Practice‖, Rajib Mall, Pearson Education India, 2006.

Course Code	Course Name	Credit
CSDLO5013	**Advanced Algorithm**	**4**

Course Objectives:

1. To provide mathematical approach for Analysis of Algorithms.
2. To teach advanced data structures.
3. To solve complex problems in real life applications.

Course Outcomes: At the end of the course student will be able to

1. Describe analysis techniques for algorithms.
2. Identify appropriate data structure and design techniques for different problems
3. Identify appropriate algorithm to be applied for the various application like geometric modeling, robotics, networking, etc.
4. Appreciate the role of probability and randomization in the analysis of algorithm
5. Analyze various algorithms.
6. Differentiate polynomial and non deterministic polynomial algorithms.

Prerequisites: Data structures, Discrete mathematics and Analysis of Algorithm

Sr. No.	**Module**	**Detailed Content**	**Hours**
1	**Fundamental of Algorithms**	**Introduction-** **Complexity-**complexity of recursive algorithms, finding complexity by tree method, master method, proving technique (contradiction, mathematical induction). **Amortized analysis-** aggregate analysis, accounting analysis, potential analysis dynamic tables	08
2	**Probabilistic Analysis and Randomized Algorithm**	The hiring problem Indicator random variables Randomized algorithms Probabilistic analysis and further uses of indicator random variable	08
3	**Advanced Data Structure**	**Introduction to trees and heap** **Red-Black Trees:** properties of red-black trees , Operations on Red-black trees **Binomial Heaps:** Binomial trees and binomial heaps, Operation on Binomial heaps **Analysis of all above operations**	12
4	**Maximum Flow**	Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08

5	**Computational Geometry**	Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08
6	**NP-Completeness And Approximation Algorithms**	NP-Completeness: NP-Completeness and reducibility, NP-Completeness proofs, NP-Complete problems-The vertex-cover problem, The travelling salesman problem	08

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, ―Introduction to Algorithms‖, PHI, India Second Edition.
2. Horowitz, Sahani and Rajsekaran, ―Fundamentals of Computer Algorithms‖, Galgotia.
3. Harsh Bhasin, ―Algorithms – Design and Analysis‖, Oxford, 2015.

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan, ― Randomized Algorithm‖, Cambridge University
2. S. K. Basu, ―Design Methods and Analysis of Algorithm‖, PHI
3. Vijay V. Vajirani, ―Approximation Algorithms‖,Springer.

Internal Assessment:

Assessment consists of two tests out of which; one (T1) should be compulsory class test (on at least 02 Modules) and the other (T2) is either a class test or assignments on live problems or course project

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Lab Code	Lab Name	Credits
CSL501	**Microprocessor Lab**	**1**

Lab Objective:

1. To emphasize on use of Assembly language program.
2. To prepare students for advanced subjects like embedded system and IOT.

Lab Outcome:

1. Use appropriate instructions to program microprocessor to perform various task
2. Develop the program in assembly/ mixed language for Intel 8086 processor
3. Demonstrate the execution and debugging of assembly/ mixed language program

Description:

A microprocessor is the most important unit within a computer system. It is responsible for processing the unique set of instructions and processes. It is a controlling unit of a computer, capable of performing Arithmetic Logical Unit (ALU) operations and communicating with the other devices connected to it. Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that are part of the microprocessor design. When computer is turned on, the microprocessor gets the first instruction from the basic input/output system that comes with the computer as part of its memory. After that, either the BIOS, or the operating system that BIOS loads into computer memory, or an application program provides instructions to perform.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8bit/16 bit data
2	Code conversion (Hex to BCD, BCD to Hex, ASCII to BCD, BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/ non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Mixed Language program to shift a number for given number of times
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order

9	Mixed Language program to increment, decrement the size of the cursor and also to disable it.
10	Assembly program to find minimum/ maximum no. from a given array.
11	Program for device driver (printer/mouse/keyboard)
12	Program based on 32 bit architecture (e.g. Switching from real mode to protected mode using DPMI driver, 32bit multiplication)
13	Assembly program to find factorial of number using procedure
14	Program and interfacing using 8255/ 8253
15	Program and interfacing of ADC/ DAC/ Stepper motor

Term Work:

Term should consist of at least 10 experiments.
Journal must include –

- At least one experiment with use of macros/ procedures
- At least five experiments with use of DOS, BIOS interrupts
- At least two assignments

At least one experiment on hardware interfacing is desirable
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum marks in term work.

Term Work: 25 marks (Total) = 15 Marks (Experiments) + 5 Marks (Assignments) + 5 Marks (Theory + Practical Attendance)

Oral & Practical exam will be based on the CSL501and CSC501 syllabus.

Lab Code	Lab Name	Credits
CSL 502	**Computer Network Lab**	**1**

Lab Objective:

To practically explore OSI layers and understand the usage of simulation tools.

Lab Outcomes:

On successful completion of course learner will be able to

1. Design and setup networking environment in Linux.
2. Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3. Implement programs using core programming APIs for understanding networking concepts.

Description

The experiments are expected to be performed in Linux environment.

Suggested List of Experiments

Sr. No	**Title of Experiments**
1.	Setup a network and configure IP addressing, subnetting, masking. (Eg. CISCO Packet Tracer, Student Ed.)
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer.
4.	Perform network discovery using discovery tools (eg. mrtg)
5.	Use Wireshark to understand the operation of TCP/IP layers : ● Ethernet Layer : Frame header, Frame size etc. ● Data Link Layer : MAC address, ARP (IP and MAC address binding) ● Network Layer : IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
6.	CRC/ Hamming code implementation.
7.	Stop and wait protocol/ sliding window (selective repeat / Go back N)
8.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
9.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following:

	● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
10.	Implementation of DVR/ LSR in NS2/(any other simulator)
11.	Socket programming using TCP or UDP
12.	Simulate congestion control (leaky bucket / token bucket).
13.	Perform File Transfer and Access using FTP
14.	Perform Remote login using Telnet server

Term Work:

Laboratory work should be based on above syllabus of suggested list having minimum 10 experiments, covering all layers.

Experiments --- (15) Marks
Assignments --- (05) Marks
Attendance (Theory + Practical) --- (05) Marks
Total --- (25) Marks

Oral & Practical exam will be based on the **above and CSC 503 : Computer Network**.

Lab Code	Lab Name	Credits
CSL503	**Database & Information System Lab**	**1**

Lab Outcome: On successful completion of course learner will be able to:

1. Design and draw ER and EER diagram for the real life problem with software tool.
2. Create and update database and tables with different DDL and DML statements.
3. Apply /Add integrity constraints and able to provide security to data.
4. Implement and execute Complex queries.
5. Apply triggers and procedures for specific module/task
6. Handle concurrent transactions and able to access data through front end (using JDBC ODBC connectivity.)

Description:

- The below suggested experiments needs to be performed by a group of **3/4 students.**
- Select any database management system and conduct all experiments based on the same topic.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create and populate database using Data Definition Language (DDL) and DML Commands for you‘re the specified System.
4	Apply Integrity Constraints for the specified system.
5	Perform Simple queries, string manipulation operations.
6	Nested queries and Complex queries
7	Perform Join operations
8	Views and Triggers
9	Functions , cursor and procedure.
10	Transaction and Concurrency control
11	Mini project- Creating a Two-tier client-server database applications using JDBC

Assignment: Perform Normalization -1NF, 2NF, 3NF

Term Work:

Laboratory work will be based on DBMS syllabus with minimum 10 experiments to be incorporated. Experiments should be completed by students on the given time duration

Experiments -- (10) Marks
Mini Project-- (10) Marks
Attendance (Theory + Practical) -- (05) Marks
Total --- (25) Marks

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Database Management System subject for given list of experiments .

Implementation ---------------------- ---(15) Marks
Oral --(10) Marks
Total --(25) Marks

****Oral & Practical exam** will be based on the above and CSC502: ‗DBMS‘ syllabus

Text Books:

1. G. K. Gupta :‖Database Management Systems‖, McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, :‖Database System Concepts‖, 6th Edition, McGraw – Hill
3. Elmasri and Navathe, ― Fundamentals of Database Systems‖, 5thEdition, PEARSON
4. Peter Rob and Carlos Coronel, ― Database Systems Design, Implementation and Management‖, Thomson Learning, 5th Edition.

Reference Books :

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
2. PaulrajPonniah, ― Introduction to Database Management‖,Wiley publication
3. Raghu Ramkrishnan and Johannes Gehrke, ― Database Management Systems‖,TMH
4. Debabrata Sahoo ―Database Management Systems‖ Tata McGraw Hill, Schaum‘s Outline

Course Code	Course Name	Credits
CSL504	**Web Design Lab**	**1**

Course objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To Create web pages and provide client side validation.
3. To create dynamic web pages using server side scripting.
4. To use MVC framework for web application development.

Course outcomes: On completion of course learner will be able to:

1. Understand the core concepts and features of Web Technology
2. Design static web pages using HTML5 and CSS3
3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery.
4. Evaluate client and server side technologies and create Interactive web pages using PHP , AJAX with database connectivity using MySQL.
5. Understand the basics of XML, DTD and XSL and develop web pages using XML / XSLT.
6. Analyze end user requirements and Create web application using appropriate web technologies and web development framework

Prerequisite: Data Structures, Basics of Programming Languages

Module No.	**Unit No.**	**Topics**	**Hrs.**
1.0		**INTRODUCTION TO WWW**	**2**
	1.1	Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	
	1.2	Overview of HTTP, HTTP request – response –– Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)	
2.0		**CLIENT SIDE PROGRAMMING**	**6**
	2.1	**Markup Language (HTML):** Introduction to HTML and HTML5 - Formatting and Fonts –Commenting Code – Anchors – Backgrounds – Images – Hyperlinks	
	2.2	Lists – Tables – Frames - HTML Forms and controls.	
	2.3	**Cascading Style Sheet (CSS):** The need for CSS, Introduction to CSS 3 – Basic syntax and structure ,CSS Properties-Inline Styles – Embedding Style Sheets	
	2.4	Linking External Style Sheets – Backgrounds –Box Model(Introduction , Border Properties, Padding Properties, Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs	
3.0		**INTRODUCTION TO JAVASCRIPT**	**6**
	3.1	Introduction - Core features - Data types and Variables - Operators, Expressions, and Statements, Functions - Objects - Array, Date and Math related Objects	
	3.2	Document Object Model - Event Handling Controlling Windows &	

		Frames and Documents Form handling and validations.	
	3.3	**Advanced JavaScript** - Browser Management and Media Management – Classes – Constructors – Object-Oriented Techniques in JavaScript	
	3.4	Object constructor and Prototyping - Sub classes and Super classes – JSON - jQuery and AJAX., Rich Internet Application with AJAX, JQuery Framework	
4.0		**SERVER SIDE PROGRAMMING**	**8**
	4.1	Introduction - Programming basics - Print/echo - Variables and constants – Strings and Arrays	
	4.2	Operators, Control structures and looping structures – Functions – Reading Data in Web Pages	
	4.3	Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication	
	4.4	AJAX with PHP - AJAX with Databases	
5.0		**XML**	**4**
	5.1	Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML –DTD(Document Type Definition) - XML Schema	
	5.2	XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language	
6.0		**WEB DEVELOPMENT FRAMEWORK**	**2**
	6.1	Introduction to Composer - MVC Architecture	
	6.2	Web Application Development using web development framework :-Introduction to Laravel, Development of Web pages using Laravel., Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.	
		Total	**28**

Text Books:

1. Ralph Moseley , M.T. Savliya ,‖ Developing Web Applications‖, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2. ―Web Technology Black Book‖, Dremtech Press, First Ediction, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm

Reference Books:

1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, ―Internet and World Wide Web - How To Program‖, Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and AtulKahate, ―Web Technologies‖, Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference‖, Third Edition, Tata McGraw Hill, 2013.

4. David Flanagan, ―JavaScript: The Definitive Guide, Sixth Edition‖, O'Reilly Media, 2011
5. Steven Holzner, ―The Complete Reference - PHP‖, Tata McGraw Hill, 2008
6. Mike Mcgrath, ―PHP & MySQL in easy Steps‖, Tata McGraw Hill, 2012.

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Term work Assessment:

Term work will consist of lab experiments testing all the technologies included in syllabus and a **Mini project** solving an appropriate problem using the above technology.

Module	Detailed Contents	Lab Sessions
1	Installation and Setting of LAMP / WAMP / XAMP	1
2	Create Simple web page using HTML5	1
3	Design and Implement web page using CSS3 and HTML5	1
4	Form Design and Client Side Validation using : a. Javascript and HTML5 b. Javascript and JQuery	2
5	Develop simple web page using PHP	1
6	Develop interactive web pages using PHP with database connectivity MYSQL	2
7	Develop XML web page using DTD, XSL	1
8	Implement a webpage using Ajax and PHP	1
9	Hosting the website with Domain Registration Process.	1
10	Design a Web application using Laravel Framework	3

* ***Setting up /buying the web host management system for hosting of mini project is recommended. Term Work:** The distribution of marks for term work shall be as follows:

- Lab Assignments : 10 Marks
- Mini Project : 10 Marks
- Attendance : 05 Marks

Practical & Oral Examination:

Practical & Oral examination is to be conducted by pair of internal and external examiners based on the above syllabus.

Course Code	Course Name	Credits
CSL505	**Business Communication & Ethics**	**02**

Course Objectives:

1. To inculcate professional and ethical attitude at the work place
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving.

Course Outcomes: Learner will be able to…

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education , upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	**Detailed Contents**	**Hrs.**
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports(Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing(IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	

06	**Employment Skills**	**07**
6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

Assessment:

List of Assignments

1. Report Writing(Theory)
2. Technical Proposal
3. Technical Paper Writing(Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills(Group activities and Role plays)
5. Interpersonal Skills(Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation(Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics(Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list. The distribution of marks for term work shall be as follows:

Book Report	**10 marks**
Assignments:	**10 marks**
Project Report Presentation:	**15 marks**
Group Discussion:	**10 marks**
Attendance:	**05 marks**

References:

1. Fred Luthans,— Organizational Behavior‖, Mc GrawHill,
2. Lesiker and Petit,— Report Writing for Business ",McGrawHill
3. R. Subramaniam,— Professional Ethics‖ Oxford University Press
4. Huckin and Olsen, —Technical Writing and Professional Communication ‖,McGraw
5. Raman and Sharma,FundamentalsofTechnicalCommunication,OxfordUniversityPress
6. Hill Wallace and Masters,— Personal Development for Life and Work‖, Thomson Learning.
7. Heta Murphy,— *Effective Business Communication* ",McGraw Hill, edition
8. R.C Sharma and Krishna Mohan,— *Business Correspondence and Report Writing",*
9. Raman Sharma, ‖*Communication Skills"*, Oxford University Press
10. B N Ghosh,— *Managing Soft Skills for Personality Development* ‖,Tata McGraw Hill
11. Dufrene, Sinha,—*BCOM*‖, Cengage Learning, 2ndedition
12. Bell. Smith,—ManagementCommunication‖WileyIndiaEdition,3rdedition.
13. Dr. K. Alex, —Soft Skills‖, S Chand and Company
14. Robbins Stephens P., —Organizational Behavior‖, Pearson Education
15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course Name	Credits
CSC601	**Software Engineering**	**4**

Course objectives:

The main objective of the course is to introduce to the students about the product that is to be engineered and the processes that provides a framework for the engineering methodologies and practices.
1. To provide the knowledge of software engineering discipline.
2. To apply analysis, design and testing principles to software project development.
3. To demonstrate and evaluate real time projects with respect to software engineering principles.

Course outcomes:

On successful completion of course, learners will be able to:
1. Understand and demonstrate basic knowledge in software engineering.
2. Identify requirements, analyze and prepare models.
3. Plan, schedule and track the progress of the projects.
4. Design & develop the software projects.
5. Identify risks, manage the change to assure quality in software projects.
6. Apply testing principles on software project and understand the maintenance concepts.

Prerequisite:
1. Concepts of Object Oriented Programming & Methodology
2. Knowledge of developing applications with front end & back end connectivity.

Course syllabus:

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction To Software Engineering and Process Models**	**08**
	1.1	Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM)	
	1.2	Generic Process Model, **Prescriptive Process Models:** The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model	
2.0		**Requirements Analysis and Modelling**	**08**
	2.1	Requirement Elicitation, Software requirement specification (SRS), Developing Use Cases (UML)	
	2.2	Requirement Model – Scenario-based model, Class-based model, Behavioural model.	
3.0		**Project Scheduling and Tracking**	**08**
	3.1	Management Spectrum, 3Ps (people, product and process)	
	3.2	Process and Project metrics	

	3.3	**Software Project Estimation:** LOC, FP, Empirical Estimation Models - COCOMO II Model, Specialized Estimation Techniques	
	3.4	**Project scheduling:** Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule, Earned Value Analysis	
4.0		**Software Design**	**10**
	4.1	Design Principles, Design Concepts, Effective Modular Design – Cohesion and Coupling	
	4.2	Architectural Design	
	4.3	Component-level design	
	4.4	User Interface Design	
5.0		**Software Risk, Configuration Management & Quality Assurance**	**08**
	5.1	Risk Identification, Risk Assessment, Risk Projection, RMMM	
	5.2	Software Configuration management, SCM repositories, SCM process	
	5.3	Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough	
6.0		**Software Testing and Maintenance**	**10**
	6.1	Strategic Approach to Software Testing, Unit testing, Integration testing Verification, Validation Testing, System Testing	
	6.2	Software Testing Fundamentals, White-Box Testing , Basis Path Testing, Control Structure Testing, Black-Box Testing,	
	6.3	Software maintenance and its types, Software Re-engineering, Reverse Engineering	
		Total	**52**

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 06 questions, each carrying 20 marks.
2. The students need to solve total 04 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Roger Pressman, ―Software Engineering: A Practitioner‘s Approach",McGraw-Hill Publications 2. Ian Sommerville, ―Software Engineering‖, Pearson Education (9th edition)
3. Ali Behfrooz and Fredeick J.Hudson, "Software Engineering Fundamentals", Oxford University Press

Reference Books:

1. Ugrasen Suman, ―Software Engineering – Concepts and Practices‖, Cengage Learning
2. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa
3. Jibitesh Mishra and Ashok Mohanty, ―Software Engineering‖, Pearson
4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India

Course Code	Course Name	Credits
CSC602	**System Programming And Compiler Construction**	**4**

Course objectives:

1. To understand the role and functioning of various system programs over application program.
2. To understand basic concepts and designing of assembler, Macro processor and role of static and dynamic loaders and linkers.
3. To understand the need to follow the syntax in writing an application program and to learn the how the analysis phase of compiler is designed to understand the programmer‘s requirements without ambiguity.
4. To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time.

Course outcomes: On successful completion of course learner will be able to:

1. Identify the relevance of different system programs.
2. Describe the various data structures and passes of assembler design.
3. Identify the need for different features and designing of macros.
4. Distinguish different loaders and linkers and their contribution in developing efficient user applications.
5. Construct different parsers for given context free grammars.
6. Justify the need synthesis phase to produce object code optimized in terms of high execution speed and less memory usage

Prerequisite: Data Structures, Theoretical computer science, Operating system. Computer Organization and Architecture, Microprocessor

Module No.	Unit No.	Topics	Hrs.
1	**Introduction to System Software**	Concept of System Software, Goals of system softwares, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	**2**
2	**Assemblers**	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for Hypothetical / X86 family processor, data structures used.	**10**
3	**Macros and Macro Processor**	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of single pass macro processor, data structures used.	**8**
4	**Loaders and Linkers**	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.	**8**

5	**Compilers: Analysis Phase**	Introduction to compilers, Phases of compilers: Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyser, data structures used . Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- Operator precedence parser, SLR Semantic Analysis, Syntax directed definitions.	**12**
6	**Compilers: Synthesis phase**	Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, Three address codes: Triples and Quadruples. Code Optimization: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. Code Generation: Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	**12**

Text Books:

1. D. M Dhamdhere: Systems programming, Tata McGraw Hill
2. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman : Compilers Principles, Techniques and Tools , Pearson Education , Second Edition.
3. J. J. Donovan: Systems Programming Tata McGraw Hill Publishing Company

Reference Books:

1. Lex &yacc, 2nd Edition by John R. Levine, Tony Mason & Doug Brown O‘Reilly
2. Compiler construction D,M.Dhamdhere second edition MACMILLAM.
3. Compiler construction : principles and practices , Kenneth C.Louden ,CENGAGE Learning
4. System software : An introduction to system programming , Leland L. Beck, Pearson

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC603	**Data Warehousing and Mining**	**4**

Course objectives:

1. To identify the scope and essentiality of Data Warehousing and Mining.
2. To analyze data, choose relevant models and algorithms for respective applications.
3. To study spatial and web data mining.
4. To develop research interest towards advances in data mining.

Course outcomes: On successful completion of course learner will be able to:

1. Understand Data Warehouse fundamentals, Data Mining Principles
2. Design data warehouse with dimensional modelling and apply OLAP operations.
3. Identify appropriate data mining algorithms to solve real world problems
4. Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5. Describe complex data types with respect to spatial and web mining.
6. Benefit the user experiences towards research and innovation.

Prerequisite: Basic database concepts, Concepts of algorithm design and analysis.

Module No.	Topics	Hrs.
1.0	**Introduction to Data Warehouse and Dimensional modelling:** Introduction to Strategic Information, Need for Strategic Information, Features of Data Warehouse, Data warehouses versus Data Marts, Top-down versus Bottom-up approach. Data warehouse architecture, metadata, E-R modelling versus Dimensional Modelling, Information Package Diagram, STAR schema, STAR schema keys, Snowflake Schema, Fact Constellation Schema, Factless Fact tables, Update to the dimension tables, Aggregate fact tables.	**8**
2.0	**ETL Process and OLAP:** Major steps in ETL process, Data extraction: Techniques, Data transformation: Basic tasks, Major transformation types, Data Loading: Applying Data, OLTP Vs OLAP, OLAP definition, Dimensional Analysis, Hypercubes, OLAP operations: Drill down, Roll up, Slice, Dice and Rotation, OLAP models : MOLAP, ROLAP.	**8**
3.0	**Introduction to Data Mining, Data Exploration and Preprocessing:** Data Mining Task Primitives, Architecture, Techniques, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration :Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Cleaning, Integration, Reduction: Attribute subset selection, Histograms, Clustering and Sampling, Data Transformation & Data Discretization: Normalization, Binning, Concept hierarchy generation, Concept Description: Attribute oriented Induction for Data Characterization.	**10**

4.0	**Classification, Prediction and Clustering:** Basic Concepts, Decision Tree using Information Gain, Induction: Attribute Selection Measures, Tree pruning, Bayesian Classification: Naive Bayes, Classifier Rule - Based Classification: Using IF-THEN Rules for classification, Prediction: Simple linear regression, Multiple linear regression Model Evaluation & Selection: Accuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap, Clustering: Distance Measures, Partitioning Methods (*k*-Means, *k*-Medoids), Hierarchical Methods(Agglomerative, Divisive)	**12**
5.0	**Mining Frequent Patterns and Association Rules:** Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, FP growth, Mining frequent Itemsets using Vertical Data Format, Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules	**8**
6.0	**Spatial and Web Mining:** Spatial Data, Spatial Vs. Classical Data Mining, Spatial Data Structures, Mining Spatial Association and Co-location Patterns, Spatial Clustering Techniques: CLARANS Extension, Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining, Applications of Web Mining	**6**
	Total	**52**

Text Books:

1. PaulrajPonniah, ―Data Warehousing: Fundamentals for IT Professionals‖, Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd edition.
3. ReemaTheraja ―Data warehousing‖, Oxford University Press.
4. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Reference Books:

1. Ian H. Witten, Eibe Frank and Mark A. Hall " Data Mining ", 3rd Edition Morgan kaufmann publisher.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.
3. R. Chattamvelli, "Data Mining Methods" 2nd Edition NarosaPublishing House.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC604	**Cryptography and System Security**	**4**

Course Objectives:

1. To introduce classical encryption techniques and concepts of modular arithmetic and number theory.
2. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3. To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
4. To develop the ability to use existing cryptographic utilities to build programs for secure communication.

Course Outcomes: At the end of the course learner will able to

1. Understand system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory.
2. Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes.
4. Apply different digital signature algorithms to achieve authentication and design secure applications
5. Understand network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.
6. Analyze and apply system security concept to recognize malicious code.

Detailed Syllabus:

Module No	Unit No	Detailed Content	Hrs
1	**Introduction & Number Theory**		10
	1.1	Security Goals, Services, Mechanisms and attacks, The OSI security architecture, Network security model, Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography.	
	1.2	Modular Arithmetic and Number Theory:- Euclid‘s algorithm–-Prime numbers-Fermat‘s and Euler‘s theorem- Testing for primality -The Chinese remainder theorem, Discrete logarithms.	
2	**Symmetric and Asymmetric key Cryptography and key Management**		12

	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC5 algorithm.	
	2.2	Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, ElGamal Algorithm.	
	2.3	Key management techniques: using symmetric and asymmetric algorithms and trusted third party. Diffie Hellman Key exchange algorithm.	
3	**Hashes, Message Digests and Digital Certificates**		06
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.	
	3.2	Digital Certificate: X.509, PKI	
4	**Authentication Protocols & Digital signature schemes**		08
	4.1	User Authentication and Entity Authentication, One-way and mutual authentication schemes, Needham Schroeder Authentication protocol, Kerberos Authentication protocol.	
	4.2	Digital Signature Schemes – RSA, EIGamal and Schnorr signature schemes.	
5	**Network Security and Applications**		10
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing.	
	5.2	Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service, Defenses against Denial of Service Attacks.	
	5.3	Internet Security Protocols: SSL, IPSEC, Secure Email: PGP, Firewalls, IDS and types, Honey pots	
6	**System Security**		06
	6.1	Software Vulnerabilities: Buffer Overflow, Format string, cross-site scripting, SQL injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.	

Text Books:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013
2. Behrouz A. Ferouzan, —Cryptography & Network Security‖, Tata Mc Graw Hill
3. Bernard Menezes, —Cryptography & Network Security‖, Cengage Learning.
4. Network Security Bible, Eric Cole, Second Edition, Wiley.

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSDLO6021	**Machine Learning**	**04**

Course Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods, clustering methods.
3. To become familiar with Dimensionality reduction Techniques.

Course Outcomes: Students will be able to-

1. Gain knowledge about basic concepts of Machine Learning
2. Identify machine learning techniques suitable for a given problem
3. Solve the problems using various machine learning techniques
4. Apply Dimensionality reduction techniques.
5. Design application using machine learning techniques

Pre-requisites: Data Structures, Basic Probability and Statistics, Algorithms

Module No.	Unit No.	Topics	Hrs.
1		**Introduction to Machine Learning** Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	6
2		**Introduction to Neural Network** Introduction – Fundamental concept – Evolution of Neural Networks – Biological Neuron, Artificial Neural Networks, NN architecture, Activation functions, McCulloch-Pitts Model.	8
3		**Introduction to Optimization Techniques:** Derivative based optimization- Steepest Descent, Newton method. Derivative free optimization**-** Random Search, Down Hill Simplex	6
4		**Learning with Regression and trees:** Learning with Regression : Linear Regression, Logistic Regression. Learning with Trees**:** Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART).	10
5		**Learning with Classification and clustering:**	14
	5.1	**Classification:** Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. **Support Vector Machine**: Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	
	5.2	**Clustering:** Expectation Maximization Algorithm, Supervised learning	

		after clustering, Radial Basis functions.	
6		**Dimensionality Reduction:** Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Single value decomposition	**8**
		Total	**52**

Text Books:

1. Peter Harrington ―Machine Learning In Action‖, DreamTech Press
2. Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press
3. Tom M.Mitchell ―Machine Learning‖ McGraw Hill
4. Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖ CRC Press
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. Samir Roy and Chakraborty, ―Introduction to soft computing‖, Pearson Edition.
7. Kevin P. Murphy , Machine Learning ― A Probabilistic Perspective‖

Reference Books:

1. Han Kamber, ―Data Mining Concepts and Techniques‖, Morgann Kaufmann Publishers
2. Margaret.H.Dunham, ―Data Mining Introductory and Advanced Topics‖, Pearson Education

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested Experiment work :

1. To implement Linear Regression.
2. To implement Logistic Regression.
3. To implement SVM.
4. To implement PCA.
5. To implement Steepest Descent
6. To implement Random search
7. To implement Naïve Baysian algorithm.
8. To implement Single layer Perceptron Learning algorithm
9. To implement Radialbasis functions.
10. Case study based on any ML technique

** **Laboratory work based on above syllabus is incorporate as mini project in CSM605: Mini-Project.**

Course Code	Course Name	Credits
CSDLO6022	**Advanced Database Management System**	4

Course objectives:

1. To provide overview of indexing and hashing techniques
2. To impart knowledge of query processing and optimization
3. To provide an overview of distributed database systems.
4. To introduce the concept of document oriented database.
5. To create awareness about potential security threats to a database and mechanisms to handle it.
6. Understand the usage of advanced data models for real life application.

Course outcomes: On successful completion of course learner will be able to:

1. Build indexing mechanisms for efficient retrieval of information from databases.
2. Measure query cost and optimize query execution
3. Design distributed database for better resource management
4. Demonstrate the understanding of the concepts of document oriented databases.
5. Apply appropriate security techniques database systems.
6. Implement advanced data models for real life applications.

Prerequisite: Basic knowledge of Database management System.

Module No.	Unit No.	Topics	Hrs.
1.0		**Indexing and Hashing Techniques**	8
	1.1	**Indexing and Hashing:** ● Operation on Files ● Hashing Techniques; Static and dynamic ● Types of Single-Level Ordered Indexes; Multilevel Indexes; Dynamic Multilevel Indexes Using B-Trees and B+-Trees; Indexes on Multiple Keys,	
2.0		**Query processing and Optimization**	12
		Query Processing : ● Overview ● Measures of Query cost ● Selection operation ● Sorting ● Join Operations, and other Operations Evaluation of Expression **Query Optimization :** ● Translations of SQL Queries into relational algebra ● Heuristic approach & cost based optimization	

3.0		**Distributed Databases**	12
	3.1	● Types of Distributed Database Systems; Distributed Database Architectures; Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design	
	3.2	● Distributed Query Processing (Semi join) ● distributed Transaction Management in Distributed Databases ● distributed Concurrency Control (locking) , Recovery in Distributed Databases {2PC/3PC) and deadlock management.	
4		**Document oriented database**	
		● Need of object oriented database. ● Impedance matching problem between OO languages and Relational database, Case study db4O ● Need of Document Oriented database, difference between Document Oriented Database and Traditional database. Types of encoding XML, JSON, BSON, Representation XML, Json Objects. Case study on doc oriented based such a Mariadb	8
5		**Advanced data models**	6
	5.1	● Temporal data models :- Aspects of valid time , Bi-temporal time and bi-temporal time with examples of each. ● Spatial model :- Types of spatial data models - Raster, Vector and Image ● Mobile databases	
	5.2	● Multimedia databases	
6		**Data Security**	**6**
	6.1	● Introduction to Database Security Issues; authorization , Discretionary Access Control Based on Granting and Revoking Privileges ● Mandatory Access Control and Role-Based	

	6.2	Access Control for Multilevel Security ● SQL Injection ● Introduction to Statistical Database Security Introduction to Flow Control	
		Total	**52**

Text Books:

1. Elmasri&Navathe— fundamentals of Database Systems‖ IV edition. PEARSON Education.
2. Korth, Silberschatzsudarshan —Database systems, concepts‖ 5th edition McGraw Hill
3. Raghu Ramkrishnan& Johannes Gehrke —Database Management System‖ Tata McGraw Hill. III edition.
4. Ruosell J.T. Dyer, Learning MySQL and Mariadb.

Reference Books:

1. Chhanda Ray , —Distributed Database System‖, Pearson Education India.
2. Hector Garcia-Molina, Jeffery D. Ullman, Jennifer Widom , — Database system Implementation‖
3. Thomas M.Connolly Carolyn Begg, Database Systems : A practical Approach to Design , Implementation and Management, 4/e.

Suggested mini. Project / Experiment work:

1. Given problem statement 2/3 student to perform-
    a. Design EER model and perform sorting, join operations for the specified problem statement.
    b. Perform the various fragmentation (Horizontal, Vertical, Derived) and check its correctness criteria.
    c. Perform two phase commit protocol (2PC)
2. Mini Project / Case study on document oriented database such a Mariadb
3. Mini Project Case study Development of an application based on any one advance data model (temporal, Spatial Multimedia)

** **Perform Laboratory (Experiments) work in the in CSM605:Mini-Project**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6023	**Enterprise Resource Planning(ERP)**	**4**

Course Objectives:

1. To understand the technical aspects and life cycle of ERP systems.
2. To understand the steps and activities in ERP.
3. To identify and describe different types of ERP system.
4. To understand tools and methodology used for designing ERP for an Enterprise.

Course Outcomes: After completion of this course, students will be able ..

1. To understand the basic structure of ERP.
2. To identify implementation strategy used for ERP.
3. To apply design principles for various business modules in ERP.
4. To apply different emerging technologies for implementation of ERP.
5. To analyze security issues in ERP.
6. To acquire ERP concepts for real world applications.

Pre-requisites: Web Engineering, Computer Network, Database Systems

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Enterprise Resource Planning (ERP)** Information System and Its Components, Value Chain Framework, Organizational Functional Units, Evolution of ERP Systems, Role of ERP in Organization, Three-Tier Architecture of ERP system.	**8**
2.0		**ERP and Implementation** ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition, implementation Methodology.	**8**
3.0		**ERP Business Modules**	**8**
	3.1	Finance, manufacturing, human resources, quality management, material management, marketing, Sales distribution and service.	
	3.2	Case study on Supply Chain management (SCM), Customer relationship Management (CRM)	
4.0		**Introduction to ERP related Technologies**	**10**
	4.1	Business Process Re-engineering (BPR) ,Data warehousing ,Data Mining, On- line Analytical Processing(OLAP), Product Life Cycle Management (PLM)	
	4.2	Geographical Information Management ,RFID, QR Code ,Bar	

		Coding, E-commerce and their application in Enterprise planning	
5.0		Extended ERP and security issues	**8**
	5.1	Enterprise application Integration (EAI), open source ERP, cloud ERP	
	5.2	Managing ERP Securities: Types of ERP security Issues, System Access security, Data Security and related technology for managing data security	
6.0		Cases of ERP for Enterprises.	**10**
	6.1	Cases of ERP like MySAP for Business suite implementation at ITC, ERP for Nestle GLOBE Project, Oracle ERP Implementation at Maruti Suzuki.	
	6.2	Need of ERP for Small and Medium size enterprises.(Zaveri)	
		Total	**52**

Text Books:

1. Alexis Leon, ERP Demystified: II Edition, Tata McGraw Hill.
2. Rajesh Ray, Enterprise Resource Planning, Text and cases, Tata McGraw Hill.
3. Sandeep Desai, Abhishek Srivastava, ERP to E^2 ERP: A Case study approach, PHI.
4. Jyotindra Zaveri, Enterprise Resource Planning, Himalaya Publishing House, 2012.

Reference Books:

1. V.K. Garg & N.K. Venkatakrishnan, Enterprise Resource Planning: concepts & practices, by ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. Enterprise wide resource planning: Theory & practice: by Rahul Altekar, PHI
4. Customer Relationship Management, Concepts and cases, Second Edition.

Mini Project / Laboratory Work:

1. Give case study 2/3 student of any organization. Make a report before-after situation at organization (Domain).
2. Make a list of Resource of the Selected Domain.
3. Categorized the Resource as per the function level process and Identify module of the domain.
4. Explain process of each module of the domain.
5. Perform Business process re-engineering (BPR) on selected Module.
6. Implement new system based on BPR.
7. Perform Impact analysis of the new system as the
   BPR. a. Prepare study on JD Edward Tool.

    b. Prepare study on Microsoft Dynamics.

8. Download any open source ERP Tool and prepare Installation Guideline and information about the Tool.
9. Make Data Entry in the Software in all modules & generate report.

** **Perform Laboratory (Experiments) work in the in CSM605:Mini-Project.**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.

- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6024	**Advance Computer Network**	**4**

Course Objective:

1. To make learners aware about advances in computer networking technologies.
2. To give overview of advance internet, QoS based and management protocols.
3. To introduce issues related to traffic engineering and capacity planning.

Course Outcomes: On successful completion of course learner will be able to

1. Demonstrate the understanding of advance data communication technologies.
2. Demonstrate the understanding of WAN Technology typically ATM .
3. Demonstrate the understanding of packet switching protocols such as X.25, X.75.
4. Explore the issues of advance internet routing protocols and also QoS based protocols.
5. Analyze issues of traffic requirements and perform capacity planning.
6. Demonstrate the understanding of protocol used for management of network.

Prerequisite: Computer Networks, ISO OSI Layered Protocols, TCP/IP protocol suite.

Module No.	**Unit No.**	**Topics**	**Hrs.**
1	**Data Communications:**		**06**
	1.1	Defining Data Communication needs, Transmission Hierarchy	
	1.2	**Optical Networks**: SONET/SDH standard, Architecture, Format, Hardware, Configuration, advantages	
2	**WAN Technology:**		**10**
	2.1	Introducing ATM Technology, Need and Benefit, Concept, Faces of ATM	
	2.2	Why ATM, BISDN Reference Model, ATM Layer, ATM Adaptation Layer, ATM Signaling	
3	**Protocols and Interfaces:**		**10**
	3.1	**Introduction to TCP/IP:** Issues in IPV4, IPV6 protocol	
	3.2	**Mature Packet Switching Protocols:** ITU Recommendation X.25, User Connectivity, Theory of Operations, Network Layer Functions, X.75 Internetworking Protocol, Advantages and Drawbacks	

4	**Advance Routing Protocols:**		14
	4.1	**Internet Routing Protocols :** OSPF, RIP, BGP **Multicast Routing:** Reverse Path Broadcasting, Internet Group Management Protocol, Reverse Path Multicasting, Discrete Vector Multicasting protocol	
	4.2	IP forwarding Architectures **Overlay Model:** Classical IP over ATM and LANE	
	4.3	**Multiprotocol Label Switching MPLS :** Fundamentals of Labels, Label Stack, VC Merging, Label Distribution Protocol, Explicit routing for Traffic Engineering	
	4.4	Integrated services, RSVP, Differentiated Services	
	4.5	**MultiMedia Over Internet:** RTP, Session Control Protocol H.323	
5	**Traffic Engineering :**		08
	5.1	**Requirement Definition:** User requirement Traffic Sizing , Traffic Characteristics, Protocols, Time and Delay Considerations	
	5.2	**Traffic Engineering and Capacity planning:**Throughput calculation, Traffic Engineering basics, Traditional traffic Engineering and Queued data and Packet Switched packet modeling, Queuing Disciplines (M/M/1), Design parameters for Peak: delay or latency, availability and reliability.	
6	**Network management**		04
	6.1	**Network Management :** SNMP Concept and format, Management Components: SMI, MIB	

Text Books:

1. M. A. Gallo and W. M. Hancock, Computer Communications and Networking Technologies, Cengage Learning, (1e).
2. Leon-Garcia, Communication Networks, Tata McGraw-Hill.
3. Darren L. Spohn, Data Network Design, Tata McGraw-Hill.
4. BehrouzForouzan, TCP/IP Protocol Suite ,McGraw-Hill, (5e).
5. William Stallings, High-Speed Networks and Internets, Pearson Education, (2e).

Reference Books:

1. Andrew Tanenbaum— Computer Networks‖, Prentice Hall, (5e).
2. Cisco Certified Network Analyst study guide, Wiley Publishing House.(7e).
3. Douglas E. Comer, Internetworking with TCP/IP Volume One, (6e).
4. James F. Kurose, Keith W. Ross, —Computer Networking, A Top-Down Approach Featuring the Internet‖,Addison Wesley, (5e).

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credits
CSL601	**Software Engineering**	**1**

Lab Outcome:

On successful completion of laboratory sessions, learners will be able to

1. Identify requirements and apply process model to selected case study.
2. Analyze and design models for the selected case study using UML modeling.
3. Use various software engineering tools.

Description:

The Software Engineering Lab has been developed by keeping in mind the following objectives:

- Select case studies to solve real life problems by applying software engineering principles.
- To impart state-of-the-art knowledge on Software Engineering and UML.

List of Experiments:

Laboratory work will be based on course syllabus with minimum 10 experiments to be incorporated. Assign case study to a group of two/three students and each group to perform the following experiments on their case study.

Sr. No.	Title of Experiments
1	Prepare detailed statement of problem for the selected / allotted mini project and identify suitable process model for the same with justification.
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project.
3	Use project management tool to prepare schedule for the project.
4	Prepare RMMM plan for the project.
5	Identify scenarios & develop UML Use case and Class Diagram for the project.
6	Draw DFD (upto 2 levels) and prepare Data Dictionary for the project.
7	Develop Activity / State Transition diagram for the project.
8	Develop Sequence and Collaboration diagram for the project.
9	Change specification and make different versions using any SCM Tool.
10	Develop test cases for the project using white box testing.

Digital Material:

Practical can be conducted using any open source software tools like Dia, Star UML, etc.

Term Work:

Term work (25 Marks) shall consist of

• Laboratory work	…..	15 marks
• Two assignments	…	05 marks
• Attendance (theory and practical)	…..	05 marks

Oral exam will be based on CSC601 and CSL601 syllabus.

Lab Code	Lab Name	Credits
CSL602	**System Software Lab**	**1**

Outcome: At the end of the course learner will be able to

1. Generate machine code by using various databases generated in pass one of two pass assembler.
2. Construct different databases of single pass macro processor.
3. Identify and validate different tokens for given high level language code.
4. Parse the given input string by constructing Top down /Bottom up parser.
5. Implement synthesis phase of compiler with code optimization techniques.
6. Explore various tools like LEX and YACC.

Description: The current System Software is highly complex with huge built in functionality offered to the programmer to develop complex applications with ease. This laboratory course aims to make a student understand-

- The need for modular design
- The need for well-defined data structures and their storage management
- The increase in the complexity of translators as we move from assembly level to high level programming
- The need to produce an efficient machine code that is optimized for both execution speed and memory requirement
- The efficient programming constructs that make them a good coder

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Implementations of two pass Assembler.
2	Implementation of single pass Macro Processor.
4	Implementation of Lexical Analyzer.
5	Implementation of Parser (Any one).
6	Implementation of Intermediate code generation phase of compiler.
7	Implementation of code generation phase of compiler.
8	Study and implement experiments on LEX. YACC, Grey Box Probing.

Reference Books:

1. Modern Compiler. Implementation in Java, Second. Edition. Andrew W. Appel Princeton University. Jens Palsberg Purdue University. CAMBRIDGE.
2. Crafting a compiler with C, Charles N. Fischer, Ron K. Cytron, Richard J. LeBlanc .

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/case studies): ……………………………..(15) Marks.
- Assignment: ...………..…………………………………………………... (05) Marks.
- Attendance ………..……………………………………………………… (05) Marks

TOTAL: ………………………………………………………………….. (25) Marks.

Oral & Practical exam will be based on the above and **CSC602** syllabus.

Lab Code	Lab Name	Credits
CSL603	**Data Warehousing and Mining Lab**	**1**

Lab Outcome:

1. Design data warehouse and perform various OLAP operations.
2. Implement classification, prediction, clustering and association rule mining algorithms.
3. Demonstrate classifications, prediction, clustering and association rule mining algorithms on a given set of data sample using data mining tools.
4. Implement spatial and web mining algorithms.

Description:
An operational database undergoes frequent changes on a daily basis on account of the transactions that take place. A data warehouses provides us generalized and consolidated data in multidimensional view. Data mining functions such as classification, prediction, clustering, and association rule mining can be integrated with OLAP operations to enhance the interactive mining of knowledge at multiple level of abstraction. Data mining supports knowledge discovery by finding hidden patterns and associations, constructing analytical models, performing classification and prediction, these mining results can be demonstrated using the data mining tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Build Data Warehouse/Data Mart for a given problem statement i) Identifying the source tables and populating sample data ii) Design dimensional data model i.e. Star schema, Snowflake schema and Fact Constellation schema (if applicable)
2	To perform various OLAP operations such as slice, dice, drilldown, rollup, pivot
3	Implementation of Classification algorithm(Decision Tree/ Bayesian)
4	Implementation of Linear Regression.
5	Implementation of Clustering algorithm(K-means/ Agglomerative).
6	Implementation of Association Rule Mining algorithm(Apriori).

7	Perform data Pre-processing task and Demonstrate performing Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA,R tool, XL Miner, etc.)
8	Implementation of page rank algorithm.
9	Implementation of HITS algorithm.
10	Implementation of Spatial Clustering Algorithm- CLARANS Extensions

Term Work:

Laboratory work will be based on above syllabus with minimum 08 experiments to be incorporated.

Experiments --- (15) Marks
Assignment-- (05) Marks
Attendance (Theory + Practical) -- (05) Marks
Total -- (25) Marks

Oral & Practical exam will be based on the above and CSC603:—Data Warehousing and Mining‖ syllabus.

Lab Code	Lab Name	Credit
CSL604	**System Security Lab**	**01**

Lab Outcome:

Learner will able to

1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers.
2. To be able to analyze and implement public key algorithms like RSA and El Gamal.
3. To analyze and evaluate performance of hashing algorithms.
4. To explore the different network reconnaissance tools to gather information about networks.
5. To explore and use tools like sniffers, port scanners and other related tools for analysing packets in a network.
6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.
7. To be able to explore various attacks like buffer-overflow, and web-application attacks.

Suggested Experiment List: (Any 10)

Sr. No	**Description**
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers
2	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools : wireshark, : 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools.
10	Simulate buffer overflow attack using Ollydbg, Splint, Cppcheck etc

11	a. Set up IPSEC under LINUX. b. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security
14	SQL injection attack, Cross-Cite Scripting attack simulation

Reference Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, TIm Boyles, Sybex.
3. Network Security Bible, Eric Cole, Wiley India.
4. Web Application Hacker‘s Handbook, Dafydd Stuttard, Marcus Pinto, Wiley India.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Experiments --- (15) Marks
Assignment-- (05) Marks
Attendance (Theory + Practical) --- (05) Marks
Total --- (25) Marks

Oral examination will be based on the above and Cryptography and System Security (CSC604) syllabus.

Lab Code	Lab Name	Credit
CSM605	**Mini-Project**	**2**

Lab Outcome: After successful completion of this Lab student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
3. Contribute as an individual or in a team in development of technical projects
4. Develop effective communication skills for presentation of project related activities

Description:

Mini project may be carried out in one or more form of following:

Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software and hardware, statistical data analysis, creating awareness in society, etc.

Guidelines:

- A project to be developed based on one or more of the following fields-
  Advance Database Management System, Enterprise Resource Planning, Advance Operating System, Advance Computer Network, etc.
- Mini project may be carried out a group of 2 /3 students. The student is required to submit a report based on the work. The evaluation of the project shall be on continuous basis.

Term Work (TW):

Distribution of marks for term work shall be as follows:

1.	Attendance	05 Marks
2.	Mini project work	10 Marks
3.	Project Report (Spiral Bound)	10 Marks

The final certification and acceptance of TW ensures the satisfactory performance on the above three aspects.

Oral & Practical Examination should be conducted by internal and external examiners appointed by University of Mumbai. Students have to give presentation and demonstration on the Mini-Project.

AC: 29/06/2021

Item No: 6.15

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 29/06/2021

Item No: 6.15

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year Engineering (Computer Engineering)**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~ / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

ncorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C’ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Engineering syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud : Chairman
Prof. Sunita Patil : Member
Prof. Leena Raga : Member
Prof. Subhash Shinde : Member
Prof. Meera Narvekar : Member
Prof. Suprtim Biswas : Member
Prof. Sudhir Sawarkar : Member
Prof. Dayanand Ingle : Member
Prof. Satish Ket : Member

Program Structure for Third Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Semester V

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Pract.**	**Theory**	**Pract.**	**Total**
CSC501	Theoretical Computer Science	3	--	3	--	3
CSC502	Software Engineering	3	--	3		3
CSC503	Computer Network	3	--	3	--	3
CSC504	Data Warehousing & Mining	3	--	3	--	3
CSDLO501x	Department Level Optional Course- 1	3	--	3	--	3
CSL501	Software Engineering Lab	--	2	--	1	1
CSL502	Computer Network Lab	--	2	--	1	1
CSL503	Data Warehousing & Mining Lab	--	2	--	1	1
CSL504	Business Comm. & Ethics II	--	2*+2	--	2	2
CSM501	Mini Project: 2 A	--	$4^{\$}$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract &oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg**					
CSC501	Theoretical Computer Science	20	20	20	80	3	25	--	125
CSC502	Software Engineering	20	20	20	80	3	--	--	100
CSC503	Computer Network	20	20	20	80	3	--	--	100
CSC504	Data Warehousing & Mining	20	20	20	80	3	--	--	100
CSDLO501x	Department Level Optional Course -1	20	20	20	80	3	--	--	100
CSL501	Software Engineering Lab	--	--	--	--	--	25	25	50
CSL502	Computer Network Lab	--	--	--	--	--	25	25	50
CSL503	Data Warehousing & Mining Lab	--	--	--	--	--	25	25	50
CSL504	Business Comm. & Ethics II	--	--	--	--	--	50	--	50
CSM501	Mini Project : 2A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

* Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

Program Structure for Third Year Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)
Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC601	System Programming & Compiler Construction	3	--	3	--	3
CSC602	Cryptography & System Security	3	--	3		3
CSC603	Mobile Computing	3	--	3	--	3
CSC604	Artificial Intelligence	3	--	3	--	3
CSDLO601x	Department Level Optional Course -2	3	--	3	--	3
CSL601	System Programming & Compiler Construction Lab	--	2	--	1	1
CSL602	Cryptography & System Security Lab	--	2	--	1	1
CSL603	Mobile Computing Lab	--	2	--	1	1
CSL604	Artificial Intelligence Lab	--	2	--	1	1
CSL605	Skill base Lab Course: Cloud Computing	--	4	--	2	2
CSM601	Mini Project Lab: 2B	--	4$^{\$}$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. &oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC601	System Programming & Compiler Construction	20	20	20	80	3	--	--	100
CSC602	Cryptography & System Security	20	20	20	80	3	--	--	100
CSC603	Mobile Computing	20	20	20	80	3	--	--	100
CSC604	Artificial Intelligence	20	20	20	80	3	--	--	100
CSDLO601x	Department Level Optional Course -2	20	20	20	80	3	--	--	100
CSL601	System Programming & Compiler Construction Lab	--	--	--	--	--	25	25	50
CSL602	Cryptography & System Security Lab	--	--	--	--	--	25	--	25
CSL603	Mobile Computing Lab	--	--	--	--	--	25	-	25
CSL604	Artificial Intelligence Lab						25	25	50
CSL605	Skill base Lab Course: Cloud Computing	--	--	--	--	--	50	25	75
CSM601	Mini Project :2B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

Program Structure for Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -1	V	CSDLO5011: Probabilistic Graphical Models CSDLO5012: Internet Programming CSDLO5013: Advance Database Management System
Department Level Optional Course -2	VI	CSDLO6011: Internet of Things CSDLO6012: Digital Signal & Image Processing CSDLO6013: Quantitative Analysis

Course Code	Course Name	Credits
CSC501	Theoretical Computer Science	3

Prerequisite: Discrete Structures	
Course Objectives:	
1.	Acquire conceptual understanding of fundamentals of grammars and languages.
2.	Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3.	Develop understanding of different types of Turing machines and applications.
4.	Understand the concept of Undecidability.
Course Outcomes: At the end of the course, the students will be able to	
1.	Understand concepts of Theoretical Computer Science, difference and equivalence of DFA and NFA , languages described by finite automata and regular expressions.
2.	Design Context free grammer, pushdown automata to recognize the language.
3.	Develop an understanding of computation through Turing Machine.
4.	Acquire fundamental understanding of decidability and undecidability.

Module No.	Unit No.	Topics	Theory Hrs.
1.0		**Basic Concepts and Finite Automata**	**09**
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM).	
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε- transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.	
2.0		**Regular Expressions and Languages**	**07**
	2.1	Regular Expression (RE),Equivalence of RE and FA, Arden‘s Theorem, RE Applications	
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.	
3.0		**Grammars**	**08**
	3.1	Grammars and Chomsky hierarchy	
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.	

	3.3	**Context Free Grammars (CFG)** Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.	
4.0		**Pushdown Automata(PDA)**	**04**
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	
5.0		**Turing Machine (TM)**	**09**
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.	
6.0		**Undecidability**	**02**
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice‘s Theorem, Post Correspondence Problem.	
		Total	**39**

Text Books:	
1.	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, ***“Introduction to Automata Theory, Languages and Computation”***, 3rd Edition, Pearson Education, 2008.
2.	Michael Sipser, **“Theory of Computation”**, 3rd Edition, Cengage learning. 2013.
3.	Vivek Kulkarni, ***“Theory of Computation”,*** Illustrated Edition, Oxford University Press, (12 April 2013) India.
Reference Books:	
1.	J. C. Martin, ***“Introduction to Languages and the Theory of Computation*”,** 4th Edition, Tata McGraw Hill Publication, 2013.
2.	Kavi Mahesh, ***“Theory of Computation: A Problem Solving Approach”***, Kindle Edition, Wiley-India, 2011.

Assessment:	
Internal Assessment:	
1.	Assessment consists of two class tests of 20 marks each.
2.	The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed.
3.	Duration of each test shall be one hour.
Term work:	
1.	Term Work should consist of at least 06 assignments (at least one assignment on each module).

2.	Assignment (best 5 assignments)	20 marks
	Attendance	5 marks
3.	It is recommended to use JFLAP software (www.jflap.org) for better teaching and learning processes.	

End Semester Theory Examination:	
1.	Question paper will comprise of 6 questions, each carrying 20 marks.
2.	The students need to solve total 4 questions.
3.	Question No.1 will be compulsory and based on entire syllabus.
4.	Remaining questions (Q.2 to Q.6) will cover all the modules of syllabus.

Useful Links:	
1.	www.jflap.org
2.	https://nptel.ac.in/courses/106/104/106104028/
3.	https://nptel.ac.in/courses/106/104/106104148/

Course Code:	Course Title	Credit
CSC502	Software Engineering	3

Prerequisite: Object Oriented Programming with Java , Python Programming	
Course Objectives:	
1	To provide the knowledge of software engineering discipline.
2	To apply analysis, design and testing principles to software project development.
3	To demonstrate and evaluate real world software projects.
Course Outcomes: On successful completion of course, learners will be able to:	
1	Identify requirements & assess the process models.
2	Plan, schedule and track the progress of the projects.
3	Design the software projects.
4	Do testing of software project.
5	Identify risks, manage the change to assure quality in software projects.

Module		Content	Hrs
1		**Introduction To Software Engineering and Process Models**	7
	1.1	Software Engineering-process framework, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering	
	1.2	Prescriptive Process Models: The Waterfall, Incremental Process Models, Evolutionary Process Models: RAD & Spiral	
	1.3	Agile process model: Extreme Programming (XP), Scrum, Kanban	
2		**Software Requirements Analysis and Modeling**	4
	2.1	Requirement Engineering, Requirement Modeling, Data flow diagram, Scenario based model	
	2.2	Software Requirement Specification document format(IEEE)	
3		**Software Estimation Metrics**	7
	3.1	Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)	
	3.2	Project Scheduling & Tracking	
4		**Software Design**	7
	4.1	Design Principles & Concepts	
	4.2	Effective Modular Design, Cohesion and Coupling, Architectural design	
5		**Software Testing**	7
	5.1	Unit testing, Integration testing,Validation testing, System testing	
	5.2	Testing Techniques, white-box testing: Basis path, Control structure testing black-box testing: Graph based, Equivalence, Boundary Value	
	5.3	Types of Software Maintenance, Re-Engineering, Reverse Engineering	
6		**Software Configuration Management, Quality Assurance and Maintenance**	7
	6.1	Risk Analysis & Management: Risk Mitigation, Monitoring and Management Plan (RMMM).	
	6.2	Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability	
	6.3	The Software Configuration Management (SCM) ,Version Control and Change Control	
			39

Textbooks:	
1	Roger Pressman, "***Software Engineering: A Practitioner's Approach"***, 9th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, ***"Software Engineering"***, 9th edition, Pearson Education, 2011
3	Ali Behfrooz and Fredeick J. Hudson, ***"Software Engineering Fundamentals"***, Oxford University Press, 1997
4	Grady Booch, James Rambaugh, Ivar Jacobson, ***"The unified modeling language user guide"***, 2nd edition, Pearson Education, 2005
References:	
1	Pankaj Jalote, ***"An integrated approach to Software Engineering"***, 3rd edition, Springer, 2005
2	Rajib Mall, ***"Fundamentals of Software Engineering"***, 5th edition, Prentice Hall India, 2014
3	Jibitesh Mishra and Ashok Mohanty, ***"Software Engineering"***, Pearson , 2011
4	Ugrasen Suman, ***"Software Engineering – Concepts and Practices"***, Cengage Learning, 2013
5	Waman S Jawadekar, ***"Software Engineering principles and practice"***, McGraw Hill Education, 2004

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Only Four questions need to be solved.
4	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx

Course Code:	Course Title	Credit
CSC503	Computer Network	3

Prerequisite: None	
Course Objectives:	
1	To introduce concepts and fundamentals of data communication and computer networks.
2	To explore the inter-working of various layers of OSI.
3	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4	To assess the strengths and weaknesses of various routing algorithms.
5	To understand various transport layer and application layer protocols.
Course Outcomes: On successful completion of course, learner will be able to	
1	Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2	Explore different design issues at data link layer.
3	Design the network using IP addressing and sub netting / supernetting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Explore protocols at application layer

Module		Content	Hrs
1		**Introduction to Networking**	4
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers.	
2		**Physical Layer**	3
	2.1	Introduction to Communication Electromagnetic Spectrum	
	2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
3		**Data Link Layer**	8
	3.1	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat)	
	3.2	**Medium Access Control sublayer** Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD)	
4		**Network layer**	12
	4.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT), IPv6	
	4.2	**Routing algorithms :** Shortest Path (Dijkastra‘s), Link state routing, Distance Vector Routing	
	4.3	**Protocols** - ARP,RARP, ICMP, IGMP	

	4.4	**Congestion control algorithms:** Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5		**Transport Layer**	**6**
	5.1	**The Transport Service**: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6		**Application Layer**	**6**
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Textbooks:	
1	A.S. Tanenbaum, **Computer Networks**,4th edition Pearson Education
2	B.A. Forouzan, **Data Communications and Networking**, 5th edition, TMH
3	James F. Kurose, Keith W. Ross, **Computer Networking, A Top-Down Approach Featuring the Internet**,6th edition, Addison Wesley
References:	
1	S.Keshav,**An Engineering Approach To Computer Networking**, Pearson
2	Natalia Olifer & Victor Olifer,**Computer Networks: Principles, Technologies & Protocols for Network Design**, Wiley India, 2011.
3	Larry L.Peterson, Bruce S.Davie, **Computer Networks: A Systems Approach**, Second Edition ,The Morgan Kaufmann Series in Networking

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://www.netacad.com/courses/networking/networking-essentials
2	https://www.coursera.org/learn/computer-networking
3	https://nptel.ac.in/courses/106/105/106105081
4	https://www.edx.org/course/introduction-to-networking

Course Code:	**Course Title**	**Credit**
CSC504	**Data Warehousing and Mining**	**3**

Prerequisite: Database Concepts	
Course Objectives:	
1.	To identify the significance of Data Warehousing and Mining.
2.	To analyze data, choose relevant models and algorithms for respective applications.
3.	To study web data mining.
4.	To develop research interest towards advances in data mining.
Course Outcomes: At the end of the course, the student will be able to	
1.	Understand data warehouse fundamentals and design data warehouse with dimensional modelling and apply OLAP operations.
2.	Understand data mining principles and perform Data preprocessing and Visualization.
3.	Identify appropriate data mining algorithms to solve real world problems.
4.	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5.	Describe complex information and social networks with respect to web mining.

Module	**Content**	**Hrs**
1	**Data Warehousing Fundamentals**	**8**
	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, E-R Modeling versus Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. Update to the dimension tables. Major steps in ETL process, OLTP versus OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
2	**Introduction to Data Mining, Data Exploration and Data Pre-processing**	**8**
	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.	
3	**Classification**	**6**
	Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap.	
4	**Clustering**	**6**
	Types of data in Cluster analysis, Partitioning Methods (*k*-Means, *k*-Medoids), Hierarchical Methods (Agglomerative, Divisive).	
5	**Mining frequent patterns and associations**	**6**
	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.	

6	**Web Mining**	5
	Introduction, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining.	

Textbooks:	
1	Paulraj Ponniah, ***" Data Warehousing: Fundamentals for IT Professionals"***, Wiley India.
2	Han, Kamber, ***"Data Mining Concepts and Techniques"***, Morgan Kaufmann 2nd edition.
3	M.H. Dunham, ***"Data Mining Introductory and Advanced Topics"***, Pearson Education.
References:	
1	Reema Theraja, ***"Data warehousing"***, Oxford University Press 2009.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, ***"Introduction to Data Mining"***, Pearson Publisher 2nd edition.
3	Ian H. Witten, Eibe Frank and Mark A. Hall, ***"Data Mining"***, Morgan Kaufmann 3rd edition.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example, If Q.2 part (a) from module 3 then part (b) can be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2	https://www.coursera.org/specializations/data-mining

Course Code:	Course Title	Credit
CSDLO5011	**Probabilistic Graphical Models**	**3**

Prerequisite: Engineering Mathematics, Discrete Structure	
Course Objectives:	
1	To give comprehensive introduction of probabilistic graphical models
2	To make inferences, learning, actions and decisions while applying these models
3	To introduce real-world trade-offs when using probabilistic graphical models in practice
4	To develop the knowledge and skills necessary to apply these models to solve real world problems.
Course Outcomes: At the end of the course, the student will be able to	
1	Understand basic concepts of probabilistic graphical modelling.
2	Model and extract inference from various graphical models like Bayesian Networks, Markov Models
3	Perform learning and take actions and decisions using probabilistic graphical models
4	Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.
5	Design real life applications using probabilistic graphical models.

Module		Content	Hrs
1.		**Introduction to Probabilistic Graphical Modeling**	**5**
	1.1	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Random Variables and Joint Distribution, Independence and Conditional Independence, Continuous Spaces, Expectation and Variances	
	1.2	Introduction to Graphs: Nodes and Edges, Subgraphs, Paths and Trails, Cycles and Loops	
	1.3	Introduction to Probabilistic Graph Models: Bayesian Network, Markov Model, Hidden Markov Model	
	1.4	Applications of PGM	
2.		**Bayesian Network Model and Inference**	**10**
	2.1	Directed Graph Model: Bayesian Network-Exploiting Independence Properties, Naive Bayes Model, Bayesian Network Model, Reasoning Patterns, Basic Independencies in Bayesian Networks, Bayesian Network Semantics, Graphs and Distributions. Modelling: Picking variables, Picking Structure, Picking Probabilities, D-separation	
	2.2	Local Probabilistic Models: Tabular CPDs, Deterministic CPDs, Context Specific CPDs, Generalized Linear Models.	

	2.3	Exact inference variable elimination: Analysis of Complexity, Variable Elimination, Conditioning, Inference with Structured CPDs.	
3.		**Markov Network Model and Inference**	**8**
	3.1	**Undirected Graph Model :** Markov Model-Markov Network, Parameterization of Markov Network, Gibb's distribution, Reduced Markov Network, Markov Network Independencies, From Distributions to Graphs, Fine Grained Parameterization, Over Parameterization	
	3.2	Exact inference variable elimination: Graph Theoretic Analysis for Variable Elimination, Conditioning	
4.		**Hidden Markov Model and Inference**	**6**
	4.1	Template Based Graph Model : HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	
5.		**Learning and Taking Actions and Decisions**	**6**
	5.1	Learning Graphical Models: Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery. Learning as Optimization: Empirical Risk, over fitting, Generalization, Evaluating Generalization Performance, Selecting a Learning Procedure, Goodness of fit, Learning Tasks. Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks	
	5.2	Causality: Conditioning and Intervention, Correlation and Causation, Causal Models, Structural Causal Identifiability, Mechanisms and Response Variables, Learning Causal Models. Utilities and Decisions: Maximizing Expected Utility, Utility Curves, Utility Elicitation. Structured Decision Problems: Decision Tree	
6.		**Applications**	**4**
	6.1	Application of Bayesian Networks: Classification, Forecasting, Decision Making	
	6.2	Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization	
	6.3	Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	

Textbooks:	
1.	Daphne Koller and Nir Friedman, **"Probabilistic Graphical Models: Principles and Techniques"**, Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139-2).
2.	David Barber, **"Bayesian Reasoning and Machine Learning"**, Cambridge University Press, 1st edition, 2011.
References:	

1.	Finn Jensen and Thomas Nielsen, **"Bayesian Networks and Decision Graphs (Information Science and Statistics)"**, 2nd Edition, Springer, 2007.
2.	Kevin P. Murphy, **"Machine Learning: A Probabilistic Perspective"**, MIT Press, 2012.
3.	Martin Wainwright and Michael Jordan, M., **"Graphical Models, Exponential Families, and Variational Inference"**, 2008.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be m onducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1.	Question paper will comprise of total six questions.
2.	All question carries equal marks
3.	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4.	Only Four question need to be solved.
5.	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1.	https://www.coursera.org/specializations/probabilistic-graphical-models
2.	https://www.mooc-list.com/tags/probabilistic-graphical-models
3.	https://scholarship.claremont.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=2690&context=cmc_theses
4.	https://www.upgrad.com/blog/bayesian-networks/
5.	https://www.utas.edu.au/__data/assets/pdf_file/0009/588474/TR_14_BNs_a_resource_guide.pdf
6.	https://math.libretexts.org/Bookshelves/Applied_Mathematics/Book%3A_Applied_Finite_Mathematics_(Sekhon_and_Bloom)/10%3A_Markov_Chains/10.02%3A_Applications_of_Markov_Chains/10.2.01%3A_Applications_of_Markov_Chains_(Exercises)
7.	https://link.springer.com/chapter/10.1007/978-3-319-43742-2_24
8.	https://homes.cs.washington.edu/~pedrod/papers/kdd02a.pdf
9.	https://core.ac.uk/download/pdf/191938826.pdf
10.	https://cs.brown.edu/research/pubs/theses/ugrad/2005/dbooksta.pdf

11.	https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm%20and%20applications.pdf
12.	https://mi.eng.cam.ac.uk/~mjfg/mjfg_NOW.pdf
13.	http://bioinfo.au.tsinghua.edu.cn/member/jgu/pgm/materials/Chapter3-LocalProbabilisticModels.pdf

Suggested List of Experiments:

Sr. No	**Experiment**
1.	Experiment on Probability Theory
2.	Experiment on Graph Theory
3.	Experiment on Bayesian Network Modelling
4.	Experiment on Markov Chain Modeling
5.	Experiment on HMM
6.	Experiment on Maximum Likelihood Estimation
7.	Decision Making using Decision Trees
8.	Learning with Optimization

**** Suggestion: Laboratory work based on above syllabus can be incorporated along with mini project in CSM501: Mini-Project.**

Course Code:	Course Title	Credit
CSDLO5012	**Internet Programming**	**3**

Prerequisite: Data Structures	
Course Objectives:	
1	To get familiar with the basics of Internet Programming.
2	To acquire knowledge and skills for creation of web site considering both client and server-side programming
3	To gain ability to develop responsive web applications
4	To explore different web extensions and web services standards
5	To learn characteristics of RIA
6	To learn React js
Course Outcomes:	
1	Implement interactive web page(s) using HTML and CSS.
2	Design a responsive web site using JavaScript
3	Demonstrate database connectivity using JDBC
4	Demonstrate Rich Internet Application using Ajax
5	Demonstrate and differentiate various Web Extensions.
6	Demonstrate web application using Reactive Js

Module		Content	Hrs
1		**Introduction to Web Technology**	**10**
	1.1	**Web Essentials**: Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers **HTML5** – fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop, Audio – Video controls **CSS3** – Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation, Basics of Bootstrap.	
2		**Front End Development**	**7**
	2.1	Java Script: An introduction to JavaScript–JavaScript DOM Model-Date and Objects-Regular Expressions- Exception Handling-Validation-Built-in objects-Event Handling, DHTML with JavaScript-JSON introduction – Syntax – Function Files – Http Request –SQL.	
3.		**Back End Development**	**7**
	3.1	**Servlets**: Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies, Installing and Configuring Apache Tomcat Web Server, **Database Connectivity**: JDBC perspectives, JDBC program example **JSP:** Understanding Java Server Pages, JSP Standard Tag Library (JSTL), Creating HTML forms by embedding JSP code.	
4		**Rich Internet Application (RIA)**	**4**
	4.1	Characteristics of RIA, **Introduction to AJAX**: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax, jQuery framework with AJAX.	
5		**Web Extension: PHP and XML**	**6**
	5.1	XML –DTD (Document Type Definition), XML Schema, Document Object Model, Presenting XML, Using XML Parsers: DOM and SAX, XSL-eXtensible Stylesheet Language	

	5.2	**Introduction to PHP-** Data types, control structures, built in functions, building web applications using PHP- tracking users, PHP and MySQLdatabase connectivity with example.	
6		**React js**	**5**
	6.1	Introduction, React features, App “Hello World” Application, Introduction to JSX, Simple Application using JSX.	
			39

Textbooks:	
1	Ralph Moseley, M.T. Savliya, “Developing Web Applications”, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2	“Web Technology Black Book”, Dremtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4	Dana Moore, Raymond Budd, Edward Benson,Professional Rich Internet Applications: AJAX and Beyond Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
5.	Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux,OREILLY, First Edition
References:	
1	Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011.
2	Achyut S Godbole and AtulKahate, ―Web Technologies, Second Edition, Tata McGraw Hill, 2012.
3	Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013
4	David Flanagan, ―JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011
5	Steven Holzner ―The Complete Reference - PHP, Tata McGraw Hill, 2008
6	Mike Mcgrath―PHP & MySQL in easy Steps, Tata McGraw Hill, 2012.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The firstclass test is to be conducted when approx. 40% syllabus is completed and the secondclass test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://books.goalkicker.com/ReactJSBook/
2	https://www.guru99.com/reactjs-tutorial.html
3	www.nptelvideos.in
4	www.w3schools.com
5	https://spoken-tutorial.org/
6	www.coursera.org
The following list can be used as a guideline for mini project:	

1	Create Simple web page using HTML5
2	Design and Implement web page using CSS3 and HTML5
3	Form Design and Client-Side Validation using: a. Javascript and HTML5, b. Javascript and Jquery
4	Develop interactive web pages using HTML 5 with JDBC database connectivity
5	Develop simple web page using PHP
6	Develop interactive web pages using PHP with database connectivity MYSQL
7	Develop XML web page using DTD, XSL
8	Implement a web page using Ajax and PHP
9	Case study based on Reactive js
10	Installation of the React DOM library.
*** Suggestion: Laboratory work based on above syllabus can be incorporated as mini project in CSM501: Mini-Project.**	

Course Code:	Course Title	Credit
CSDLO5013	**Advance Database Management System**	**3**

Prerequisite: Database Management System	
Course Objectives:	
1	To provide insights into distributed database designing
2	To specify the various approaches used for using XML and JSON technologies.
3	To apply the concepts behind the various types of NoSQL databases and utilize it for Mongodb
4	To learn about the trends in advance databases
Course Outcomes: After the successful completion of this course learner will be able to:	
1	Design distributed database using the various techniques for query processing
2	Measure query cost and perform distributed transaction management
3	Organize the data using XML and JSON database for better interoperability
4	Compare different types of NoSQL databases
5	Formulate NoSQL queries using Mongodb
6	Describe various trends in advance databases through temporal, graph based and spatial based databases

Module		Content	Hrs
1		**Distributed Databases**	**3**
	1.1	Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design.	
2		**Distributed Database Handling**	**8**
	2.1	Distributed Transaction Management – Definition, properties, types, architecture Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing.	
	2.2	Distributed Concurrency Control- Taxonomy, Locking based, Basic TO algorithm, Recovery in Distributed Databases: Failures in distributed database, 2PC and 3PC protocol.	
3		**Data interoperability – XML and JSON**	**6**
	3.1	XML Databases: Document Type Definition, XML Schema, Querying and Transformation: XPath and XQuery.	
	3.2	Basic JSON syntax, (Java Script Object Notation),JSON data types, Stringifying and parsing the JSON for sending & receiving, JSON Object retrieval using key-value pair and JQuery, XML Vs JSON	
4		**NoSQL Distribution Model**	**10**
	4.1	NoSQL database concepts: NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system.	
	4.2	Replication and sharding, Distribution Models Consistency in distributed data, CAP theorem, Notion of ACID Vs BASE, handling Transactions, consistency and eventual consistency	
	4.3	Types of NoSQL databases: Key-value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
5		**NoSQL using MongoDB**	**6**

	5.1	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents	
	5.2	Querying MongoDB using find() functions, advanced queries using logical operators and sorting, simple aggregate functions, saving and updating document. MongoDB Distributed environment: Concepts of replication and horizonal scaling through sharding in MongoDB	
6		**Trends in advance databases**	**6**
	6.1	**Temporal database:** Concepts, time representation, time dimension, incorporating time in relational databases.	
	6.2	**Graph Database:** Introduction, Features, Transactions, consistency, Availability, Querying, Case Study Neo4J	
	6.3	**Spatial database:** Introduction, data types, models, operators and queries	
			39

Textbooks:	
1	Korth, Siberchatz,Sudarshan, “Database System Concepts”, 6thEdition, McGraw Hill
2	Elmasri and Navathe, “Fundamentals of Database Systems”, 5thEdition, Pearson Education
3	Ozsu, M. Tamer, Valduriez, Patrick, “Principles of distributed database systems”,3rd Edition, Pearson Education, Inc.
4	PramodSadalge, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesely/ Pearson
5	Jeff Friesen , Java XML and JSON,Second Edition, 2019, après Inc.
References:	
1	Peter Rob and Carlos Coronel,Database Systems Design, Implementation and Management, Thomson Learning, 5thEdition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.
4	Shashank Tiwari, Professional NOSQL, John Willy & Sons. Inc
5	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
6	MongoDB Manual : https://docs.mongodb.com/manual

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.
NOTE: Suggested that in Mini Projects (CSM501) can be included NoSQL databases for implementation as a backend.	

Useful Links	
1	https://cassandra.apache.org
2	https://www.mongodb.com
3	https://riak.com
4	https://neo4j.com
5	https://martinfowler.com/articles/nosql-intro-original.pdf

Lab Code	Lab Name	Credit
CSL501	**Software Engineering Lab**	**1**

Prerequisite: Object Oriented Programming with Java , Python Programming	
Lab Objectives:	
1	To solve real life problems by applying software engineering principles
2	To impart state-of-the-art knowledge on Software Engineering
Lab Outcomes: On successful completion of laboratory experiments, learners will be able to :	
1	Identify requirements and apply software process model to selected case study.
2	Develop architectural models for the selected case study.
3	Use computer-aided software engineering (CASE) tools.

Suggested List of Experiments - Assign the case study/project as detail statement of problem to a group of two/three students. Laboratory work will be based on course syllabus with minimum 10 experiments. Open source computer-aided software engineering (CASE) tools can be used for performing the experiment.

Sr. No.	Title of Experiment
1	Application of at least two traditional process models.
2	Application of the Agile process models.
3	Preparation of software requirement specification (SRS) document in IEEE format.
4	Structured data flow analysis.
5	Use of metrics to estimate the cost.
6	Scheduling & tracking of the project.
7	Write test cases for black box testing.
8	Write test cases for white box testing.
9	Preparation of Risk Mitigation, Monitoring and Management Plan (RMMM).
10	Version controlling of the project.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC502 and CSL501 syllabus

Lab Code	Lab Name	Credit
CSL502	**Computer Network Lab**	**1**

Prerequisite: None	
Lab Objectives:	
1	To practically explore OSI layers and understand the usage of simulation tools.
2	To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3	To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols
Lab Outcomes: On successful completion of lab, learner will be able to	
1	Design and setup networking environment in Linux.
2	Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3	Implement programs using core programming APIs for understanding networking concepts.

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1.	Study of RJ45 and CAT6 Cabling and connection using crimping tool.
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.
4.	Perform network discovery using discovery tools (eg. Nmap, mrtg)
5.	Use Wire shark to understand the operation of TCP/IP layers: ● Ethernet Layer: Frame header, Frame size etc. ● Data Link Layer: MAC address, ARP (IP and MAC address binding) ● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
6.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
7.	Study and Installation of Network Simulator (NS3)
8.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following: ● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
9	Design VPN and Configure RIP/OSPF using Packet tracer.
10.	Socket programming using TCP or UDP
11.	Perform File Transfer and Access using FTP
12.	Perform Remote login using Telnet server

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Computer Network”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks,

	Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC503: Computer Network

Useful Links	
1	https://www.netacad.com/courses/packet-tracer/introduction-packet-tracer
2	https://www.coursera.org/projects/data-forwarding-computer-networks
3	https://www.edx.org/course/ilabx-the-internet-masterclass

Lab Code	Lab Name	Credit
CSL503	Data Warehousing and Mining Lab	1

Prerequisite: Database Concepts	
Lab Objectives:	
1.	Learn how to build a data warehouse and query it.
2.	Learn about the data sets and data preprocessing.
3.	Demonstrate the working of algorithms for data mining tasks such Classification, clustering, Association rule mining & Web mining
4.	Apply the data mining techniques with varied input values for different parameters.
5.	Explore open source software (like WEKA) to perform data mining tasks.
Lab Outcomes: At the end of the course, the student will be able to	
1.	Design data warehouse and perform various OLAP operations.
2.	Implement data mining algorithms like classification.
3.	Implement clustering algorithms on a given set of data sample.
4.	Implement Association rule mining & web mining algorithm.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	One case study on building Data warehouse/Data Mart • Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema)
2	Implementation of all dimension table and fact table based on experiment 1 case study
3	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot based on experiment 1 case study
4	Implementation of Bayesian algorithm
5	Implementation of Data Discretization (any one) & Visualization (any one)
6	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA/R tool)
7	Implementation of Clustering algorithm (K-means/K-medoids)
8	Implementation of any one Hierarchical Clustering method
9	Implementation of Association Rule Mining algorithm (Apriori)
10	Implementation of Page rank/HITS algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 1 assignment on content of theory and practical of “Data Warehousing and Mining”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC504 : Data Warehousing and Mining

Course Code	Course Name	Credit
CSL504	**Business Communication & Ethics II**	**02**

Course Rationale: This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	
1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code of ethics.
Course Outcomes: At the end of the course, the student will be able to	
1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)**	**06**
	Purpose and Classification of Reports: **Classification on the basis of:** Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long) **Parts of a Long Formal Report:** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter) **Language and Style of Reports:** Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers **Definition, Purpose & Types of Proposals:** Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals) **Parts of a Proposal:** Elements, Scope and Limitations, Conclusion **Technical Paper Writing:** Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	

2	**EMPLOYMENT SKILLS**	**06**
	Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination) **Statement of Purpose:** Importance of SOP, Tips for Writing an Effective SOP **Verbal Aptitude Test:** Modelled on CAT, GRE, GMAT exams **Group Discussions:** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes **Personal Interviews:** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3	**BUSINESS MEETINGS**	**02**
	Conducting Business Meetings: Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette **Documentation:** Notice, Agenda, Minutes	
4	**TECHNICAL/ BUSINESS PRESENTATIONS**	**02**
	Effective Presentation Strategies: Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting &Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform skills **Group Presentations:** Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5	**INTERPERSONAL SKILLS**	**08**
	Interpersonal Skills: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making **Start-up Skills:** Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
6	**CORPORATE ETHICS**	**02**
	Intellectual Property Rights: Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information) **Case Studies:** Cases related to Business/ Corporate Ethics	

List of assignments: (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)	
Sr. No.	**Title of Experiment**
1	Cover Letter and Resume
2	Short Proposal
3	Meeting Documentation
4	Writing a Technical Paper/ Analyzing a Published Technical Paper
5	Writing a SOP
6	IPR
7	Interpersonal Skills
Note:	
1	The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).

2	The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3	There will be an end–semester presentation based on the book report.
Assessment:	
Term Work:	
1	Term work shall consist of minimum 8 experiments.
2	The distribution of marks for term work shall be as follows: Assignment : 10 Marks Attendance : 5 Marks Presentation slides : 5 Marks Book Report (hard copy) : 5 Marks
3	The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Internal oral: **Oral Examination will be based on a GD & the Project/Book Report presentation.**	
	Group Discussion : 10 marks Project Presentation : 10 Marks Group Dynamics : 5 Marks
Books Recommended: Textbooks and Reference books	
1	Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2	Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3	Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4	Masters, L. A., Wallace, H. R., & Harwood, L. (2011). *Personal development for life and work*. Mason: South-Western Cengage Learning.
5	Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
6	Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7	Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press
8	Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Course Code	Course Name	Credits
CSM501	**Mini Project 2A**	**02**

Objectives	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members and inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature surveys
2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations
4	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. ● The work may result in research/white paper/ article/blog writing and publication ● The work may result in business plan for entrepreneurship product created ● The work may result in patent filing.
7	Gain technical competency towards participation in Competitions, Hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work as a member of a group or as leader
Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor or head of department/internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of

	annexure to the report.
9	With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work		
The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester.		
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.		
Distribution of Term work marks for both semesters shall be as below:		**Marks 25**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In one-year project (sem V and VI), first semester the entire theoretical solution shall be made ready, including components/system selection and cost analysis. Two reviews will be conducted based on a presentation given by a student group. ☐ First shall be for finalization of problem ☐ Second shall be on finalization of proposed solution of problem.	
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ☐ First review is based on readiness of building working prototype to be conducted. ☐ Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, ☐ Identification of need/problem ☐ Proposed final solution ☐ Procurement of components/systems ☐ Building prototype and testing	
2	Two reviews will be conducted for continuous assessment, ☐ First shall be for finalization of problem and proposed solution ☐ Second shall be for implementation and testing of solution.	

Mini Project shall be assessed based on following points	
1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement Gathering via SRS/ Feasibility Study
3	Completeness of methodology implemented
4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution/ Test Cases
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met

In one year project (sem V and VI), first semester evaluation may be based on first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.
In case of half year projects (completing in V sem) all criteria in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

Course Code:	Course Title	Credit
CSC601	**System Programming and Compiler Construction**	**3**

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture .	
Course Objectives:	
1	To understand the role and functionality of various system programs over application programs.
2	To understand basic concepts, structure and design of assemblers, macro processors, linkers and loaders.
3	To understand the basic principles of compiler design, its various constituent parts, algorithms and data structures required to be used in the compiler.
4	To understand the need to follow the syntax in writing an application program and to learn how the analysis phase of compiler is designed to understand the programmer ‘s requirements without ambiguity
5	To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time
Course Outcomes: On successful completion of course, learner will be able to	
1	Identify the relevance of different system programs.
2	Explain various data structures used for assembler and microprocessor design.
3	Distinguish between different loaders and linkers and their contribution in developing efficient user applications.
4	Understand fundamentals of compiler design and identify the relationships among different phases of the compiler.

Module		Content	Hrs
1		**Introduction to System Software**	**2**
	1.1	Concept of System Software, Goals of system software, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	
2		**Assemblers**	7
	2.1	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for X86 processor, data structures used.	
3		**Macros and Macro Processor**	6
	3.1	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of Two pass macro processor, data structures used.	
4		**Loaders and Linkers**	**6**
	4.1	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.	
5		**Compilers: Analysis Phase**	**10**
	5.1	Introduction to compilers, Phases of compilers: **Lexical Analysis**- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyzer, data structures used.	

		Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- SR Parser, Operator precedence parser, SLR. **Semantic Analysis**, Syntax directed definitions.	
6		**Compilers: Synthesis phase**	**8**
	6.1	**Intermediate Code Generation**: Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and Quadruples, indirect triple. **Code Optimization**: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. **Code Generation:** Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	

Textbooks:	
1	D. M Dhamdhere: *Systems programming and Operating Systems,* Tata McGraw Hill, Revised Second Edition
2	A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: *Compilers Principles, Techniques and Tools,* Pearson Education, Second Edition.
3	J. J. Donovan: *Systems Programming* Tata McGraw Hill, Edition 1991
References:	
1	John R. Levine, Tony Mason & Doug Brown, *Lex & YACC*, O 'Reilly publication, second Edition
2	D, M .Dhamdhere ,*Compiler construction* 2e, Macmillan publication, second edition .
3	Kenneth C. Louden ,*Compiler construction: principles and practices*, Cengage Learning
4	Leland L. Beck, *System software: An introduction to system programming*, Pearson publication, Third Edition
Useful Links for E-resources:	
1	http://www.nptelvideos.in/2012/11/compiler-design.html
2	https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first -class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSC602	Cryptography & System Security	3

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce classical encryption techniques and concepts of modular arithmetic and number theory.
2	To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3	To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS.
4	To develop the ability to use existing cryptographic utilities to build programs for secure communication
Course Outcomes:	
1	Understand system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory
2	Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3	Apply different message digest and digital signature algorithms to verify integrity and achieve authentication and design secure applications
4	Understand network security basics, analyse different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP
5	Analyse and apply system security concept to recognize malicious code

Module		Content	Hrs
1		**Introduction - Number Theory and Basic Cryptography**	8
	1.1	Security Goals, Attacks, Services and Mechanisms, Techniques. Modular Arithmetic: Euclidean Algorithm, Fermat‘s and Euler‘s theorem	
	1.2	Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and polyalphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers	
2		**Symmetric and Asymmetric key Cryptography and key Management**	11
	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC4 algorithm.	
	2.2	Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem, The knapsack cryptosystem	
	2.3	Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, Public key Distribution: Digital Certificate: X.509, PKI	
3		**Cryptographic Hash Functions**	3
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.	
4		**Authentication Protocols & Digital Signature Schemes**	5
	4.1	User Authentication, Entity Authentication: Password Base, Challenge Response Based	

	4.2	Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA	
5		**Network Security and Applications**	**9**
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing	
	5.2	Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service	
	5.3	Internet Security Protocols: PGP, SSL, IPSEC. Network security: IDS, Firewalls	
6		**System Security**	**3**
	6.1	Buffer Overflow, malicious Programs: Worms and Viruses, SQL injection	

Textbooks:	
1	William Stallings, ***“Cryptography and Network Security, Principles and Practice”***, 6th Edition, Pearson Education, March 2013
2	Behrouz A. Ferouzan, ***“Cryptography & Network Security”***, Tata McGraw Hill
3	Behrouz A. Forouzan & Debdeep Mukhopadhyay, ***“Cryptography and Network Security”*** 3rd Edition, McGraw Hill

Referecebooks:	
1	Bruce Schneier, ***“Applied Cryptography, Protocols Algorithms and Source Code in C”,*** Second Edition, Wiley.
2	Atul Kahate, ***“Cryptography and Network Security”,*** Tata McGraw-Hill Education, 2003.
3	Eric Cole, ***“Network Security Bible”,*** Second Edition, Wiley, 2011.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://github.com/cmin764/cmiN/blob/master/FII/L3/SI/book/W.Stallings%20-%20Cryptography%20and%20Network%20Security%206th%20ed.pdf
2	https://docs.google.com/file/d/0B5F6yMKYDUbrYXE4X1ZCUHpLNnc/view

Course Code:	Course Title	Credit
CSC603	Mobile Computing	3

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications.
2	To explore both theoretical and practical issues of mobile computing.
3	To provide an opportunity for students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.
Course Outcomes: On successful completion of course, learner will be able to	
1	To identify basic concepts and principles in computing, cellular architecture.
2	To describe the components and functioning of mobile networking.
3	To classify variety of security techniques in mobile network.
4	To apply the concepts of WLAN for local as well as remote applications.
5	To describe Long Term Evolution (LTE) architecture and its interfaces.

Module		Content	Hrs
1		**Introduction to Mobile Computing**	**4**
	1.1	Introduction to Mobile Computing, Telecommunication Generations, Cellular systems,	
	1.2	Electromagnetic Spectrum, Antenna, Signal Propagation, Signal Characteristics, Multiplexing, Spread Spectrum: DSSS & FHSS, Co-channel interference	
2		**GSM Mobile services**	**8**
	2.1	GSM Mobile services, System Architecture, Radio interface, Protocols, Localization and Calling, Handover, security (A3, A5 & A8)	
	2.2	GPRS system and protocol architecture	
	2.3	UTRAN, UMTS core network; Improvements on Core Network,	
3		**Mobile Networking**	**8**
	3.1	Medium Access Protocol, Internet Protocol and Transport layer	
	3.2	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Reverse Tunneling.	
	3.3	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission	
4		**Wireless Local Area Networks**	**6**
	4.1	**Wireless Local Area Networks:** Introduction, Infrastructure and ad-hoc network	
	4.2	**IEEE 802.11:**System architecture , Protocol architecture , Physical layer, Medium access control layer, MAC management, 802.11a, 802.11b standard	
	4.3	Wi-Fi security : WEP ,WPA, Wireless LAN Threats , Securing Wireless Networks	

	4.4	Bluetooth: Introduction, User Scenario, Architecture, protocol stack	
5		**Mobility Management**	**6**
	5.1	**Mobility Management :** Introduction, IP Mobility, Optimization, IPv6	
	5.2	Macro Mobility : MIPv6, FMIPv6	
	5.3	Micro Mobility: CellularIP, HAWAII, HMIPv6	
6		**Long-Term Evolution (LTE) of 3GPP**	**7**
	6.1	**Long-Term Evolution (LTE) of 3GPP :** LTE System Overview, Evolution from UMTS to LTE	
	6.2	LTE/SAE Requirements, SAE Architecture	
	6.3	EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to LTE-Advanced	
	6.4	Self Organizing Network (SON-LTE), SON for Heterogeneous Networks (HetNet), Comparison between Different Generations (2G, 3G, 4G and 5G), Introduction to 5G	

Textbooks:	
1	Jochen Schilller, “**Mobile Communication**”, Addision wisely, Pearson Education
2	William Stallings “**Wireless Communications & Networks**”, Second Edition, Pearson Education
3	Christopher Cox, “**An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications**”, Wiley publications
4	Raj Kamal, **“Mobile Computing”**, 2/e, Oxford University Press-New
References:	
1	Seppo Hamalainen, Henning Sanneck , Cinzia Sartori, **“LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency”,** Wiley publications
2	Ashutosh Dutta, Henning Schulzrinne **“Mobility Protocols and Handover Optimization: Design, Evaluation and Application”,** IEEE Press, Wiley Publication
3	Michael Gregg, **“Build your own security lab”,** Wiley India edition
4	Dipankar Raychaudhuri, Mario Gerla, **“Emerging Wireless Technologies and the Future Mobile Internet”,** Cambridge
5	Andreas F. Molisch, **“Wireless Communications”,** Second Edition, Wiley Publication

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://www.coursera.org/learn/smart-device-mobile-emerging-technologies
2	https://nptel.ac.in/courses/106/106/106106167/

Course Code:	Course Title	Credit
CSC604	**Artificial Intelligence**	**3**

Prerequisite: Discrete Mathematics, Data Structures	
Course Objectives:	
1	To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2	To make students understand and Explore the mechanism of mind that enables intelligent thought and action.
3	To make students understand advanced representation formalism and search techniques.
4	To make students understand how to deal with uncertain and incomplete information.
Course Outcomes: At the end of the course, the students will be able to	
1	Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2	Ability to choose an appropriate problem solving method and knowledge representation technique.
3	Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4	Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5	Ability to design and develop AI applications in real world scenarios.

Module		Content	Hrs
1		**Introduction to Artificial Intelligence**	**4**
	1.1	Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.	
2		**Intelligent Agents**	**4**
	2.1	Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	
	2.2	Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems.	
3		**Problem solving**	**10**
	3.1	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search.	
	3.2	Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Genetic algorithms.	
	3.3	**Adversarial Search:** Game Playing, Min-Max Search, Alpha Beta Pruning	
4		**Knowledge and Reasoning**	**12**
	4.1	Knowledge based Agents, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining.	
	4.2	Knowledge Engineering in First-Order Logic, Unification, Resolution	

	4.3	Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network	
5		**Planning and Learning**	**5**
	5.1	The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning.	
	5.2	Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to statistical learning (Introduction only) Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning	
6		**AI Applications**	**4**
		A. Introduction to NLP- Language models, Grammars, Parsing B. Robotics - Robots, Robot hardware, Problems Robotics can solve C. AI applications in Healthcare, Retail, Banking	

Textbooks:	
1	Stuart J. Russell and Peter Norvig, "***Artificial Intelligence: A Modern Approach***", Fourth Edition" Pearson Education, 2020.
2	Saroj Kaushik, "***Artificial Intelligence***", Cengage Learning, First edition, 2011
3	George F Luger, "***Artificial Intelligence***" Low Price Edition, Fourth edition, Pearson Education.,2005
References:	
1	Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3	Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4	Elaine Rich and Kevin Knight, "***Artificial Intelligence***", Third Edition, McGraw Hill Education,2017.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105078/
2	https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students-and-beginners/
3	https://nptel.ac.in/courses/106/105/106105079/

Course Code:	Course Title	Credit
CSDLO6011	**Internet of Things**	**3**

Prerequisite: C Programming, Digital Logic and Computer Architecture, Microprocessor, Computer Networks.	
Course Objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Internet of Things (IoT).
2	To emphasize on core IoT functional Stack to build assembly language programs. To learn the Core IoT Functional Stack.
3	To understand the different common application protocols for IoT and apply IoT knowledge to key industries that IoT is revolutionizing.
4	To examines various IoT hardware items and software platforms used in projects for each platform that can be undertaken by a beginner, hobbyist, student, academician, or researcher to develop useful projects or products.
Course Outcomes: On the completion of the course, learners will be able to:	
1	Understand the concepts of IoT and the Things in IoT.
2	Emphasize core IoT functional Stack and understand application protocols for IoT.
3	Apply IoT knowledge to key industries that IoT is revolutionizing.
4	Examines various IoT hardware items and software platforms used in projects.

Module		Content	Hrs
1		**Introduction to Internet of Things (IoT)**	**7**
	1.1	What is IoT? - IoT and Digitization	
	1.2	IoT Impact – Connected Roadways, Connected Factory, Smart Connected Buildings, Smart Creatures	
	1.3	Convergence of IT and OT, IoT Challenges	
	1.4	The oneM2M IoT Standardized Architecture	
	1.5	The IoT World Forum (IoTWF) Standardized Architecture	
	1.6	IoT Data Management and Compute Stack – Design considerations and Data related problems, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud	
2		**Things in IoT**	**7**
	2.1	Sensors/Transducers – Definition, Principles, Classifications, Types, Characteristics and Specifications	
	2.2	Actuators – Definition, Principles, Classifications, Types, Characteristics and Specifications	
	2.3	Smart Object – Definition, Characteristics and Trends	
	2.4	Sensor Networks – Architecture of Wireless Sensor Network, Network Topologies	
	2.5	Enabling IoT Technologies - Radio Frequency Identification Technology, Micro-Electro-Mechanical Systems (MEMS), NFC (Near Field Communication), Bluetooth Low Energy (BLE), LTE-A (LTE Advanced), IEEE 802.15.4– Standardization and Alliances, ZigBee.	
3		**The Core IoT Functional Stack**	**6**
	3.1	Layer 1 – Things: Sensors and Actuators Layer	

	3.2	Layer 2 – Communications Network Layer, Access Network Sublayer, Gateways and Backhaul Sublayer, Network Transport Sublayer, IoT Network Management Sublayer	
	3.3	Layer 3 – Applications and Analytics Layer, Analytics Vs. Control Applications, Data Vs. Network Analytics, Data Analytics Vs. Business Benefits, Smart Services	
4		**Application Protocols for IoT**	**7**
	4.1	The Transport Layer	
	4.2	IoT Application Transport Methods	
	4.3	Application Layer Protocol Not Present	
	4.4	SCADA - Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T,	
	4.5	Generic Web-Based Protocols	
	4.6	IoT Application Layer Protocols – CoAP and MQTT	
5		**Domain Specific IoTs**	**6**
	5.1	Home Automation – Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors	
	5.2	Cities – Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance	
	5.3	Environment – Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection	
	5.4	Energy – Smart Grids, Renewable Energy Systems, Prognostics	
	5.5	Retail – Inventory Management, Smart Payments, Smart Vending Machines	
	5.6	Logistics – Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring	
	5.7	Agriculture – Smart Irrigation, Green House Control	
	5.8	Industry – Machine Diagnostics & Prognosis, Indoor Air Quality Monitoring	
	5.9	Health & Lifestyle – Health & Fitness Monitoring, Wearable Electronics	
6		**Create your own IoT**	**6**
	6.1	IoT Hardware - Arduino, Raspberry Pi, ESP32, Cloudbit/Littlebits, Particle Photon, Beaglebone Black.	
	6.2	IoT Software - languages for programming IoT hardware, for middleware applications and API development, for making front ends, REST and JSON-LD	
	6.3	A comparison of IoT boards and platforms in terms of computing	
	6.4	A comparison of IoT boards and platforms in terms of development environments and communication standards	
	6.5	A comparison of boards and platforms in terms of connectivity	
	6.6	A comparison of IoT software platforms	

Textbooks:	
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, ***"IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things",*** 1st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.

2	Hakima Chaouchi, ***"The Internet of Things - Connecting Objects to the Web",*** 1st Edition, Wiley, 2010.
3	Perry Lea, ***"Internet of things For Architects",*** 1st Edition, Packt Publication, 2018
4	Arshdeep Bahga, Vijay Madisetti, ***"Internet of Things – Hands-On Approach",*** 2nd Edition, Universities Press, 2016.
References:	
1	Adrian McEwen & Hakim Cassimally, ***"Designing the Internet of Things",*** 1st Edition, Wiley, 2014.
2	Donald Norris, ***"Raspberry Pi – Projects for the Evil Genius",*** 2nd Edition, McGraw Hill, 2014.
3	Anand Tamboli ,***"Build Your Own IoT Platform",*** 1st Edition, Apress, 2019.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105166/
2	https://nptel.ac.in/courses/108/108/108108098/
3	https://nptel.ac.in/courses/106/105/106105195/
4	https://www.coursera.org/specializations/IoT

Course Code:	Course Title	Credit
CSDLO6012	Digital Signal & Image Processing	3

Prerequisite: Applied Engineering Mathematics	
Course Objectives:	
1	To understand the fundamental concepts of digital signal processing and Image processing
2	To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3	To apply processing techniques on 1-D and Image signals
4	To apply digital image processing techniques for edge detection
Course Outcomes: On successful completion of course, learners will be able to:	
1	Understand the concept of DT Signal and DT Systems
2	Classify and analyze discrete time signals and systems
3	Implement Digital Signal Transform techniques DFT and FFT
4	Use the enhancement techniques for digital Image Processing
5	Apply image segmentation techniques

Module No.	Unit No.	Topic details	Hrs.
1.0		**Discrete-Time Signal and Discrete-Time System**	**10**
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication).	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems	
	1.3	Linear Convolution formulation for 1-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, Concept of LTI system, Output of DT system using Time Domain Linear Convolution.	
2.0		**Discrete Fourier Transform**	**05**
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT	
	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parseval’s Energy Theorem). DFT computation using DFT properties.	
	2.3	Convolution of long sequences, Introduction to 2-D DFT	
3.0		**Fast Fourier Transform**	**04**
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm,	
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm.	
	3.3	Spectral Analysis using FFT	
4.0		**Digital Image Fundamentals**	**05**
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization	
	4.2	Representation of Digital Image, Connectivity	
	4.3	Image File Formats: BMP, TIFF and JPEG.	
5.0		**Image Enhancement in Spatial domain**	**09**
	5.1	Gray Level Transformations, Zero Memory Point Operations,	
	5.2	Histogram Processing, Histogram equalization.	

	5.3	Neighborhood processing, Image averaging, Image Subtraction, Smoothing Filters - Low pass averaging, Sharpening Filters-High Pass Filter, High Boost Filter, Median Filter for reduction of noise	
6.0		**Image Segmentation**	**06**
	6.1	Fundamentals. Segmentation based on Discontinuities and Similarities	
	6.2	Point, line and Edge Detection, Image edge detection using Robert, Prewitt and Sobel masks, Image edge Detection using Laplacian mask	
	6.3	Region based segmentation: Region Growing, Region Splitting and Merging	
		Total	**39**

Textbooks:	
1	John G. Proakis, Dimitris and G .Manolakis, **“Digital Signal Processing: Principles, Algorithms, and Applications”**, 4th Edition, Pearson Education, 2007
2	A. Anand Kumar, **“Digital Signal Processing”**, 2nd Edition, PHI Learning Pvt. Ltd. 2014.
3	Rafel C. Gonzalez and Richard E. Woods, **“Digital Image Processing”**, Pearson Education Asia, 4th Edition, 2018.
4	S. Sridhar, **“Digital Image Processing”**, 2nd Edition, Oxford University Press, 2012.
References:	
1	Sanjit Mitra, **“Digital Signal Processing: A Computer Based Approach”**, 4th Edition, Tata McGraw Hill, 2013
2	S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, **“Digital Signal Processing”**, 2nd Edition, Tata McGraw Hill Publication, 2011.
3	S. Jayaraman, E. Esakkirajan and T. Veerkumar, **“Digital Image Processing”**, 3rd Edition, Tata McGraw Hill Education Private Ltd, 2009.
4	Anil K. Jain, **“Fundamentals of Digital Image Processing”**, 4th Edition, Prentice Hall of India Private Ltd,.1989
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 50% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/
2	https://swayam.gov.in

Course Code:	Course Title	Credit
CSDLO6013	**Quantitative Analysis**	**3**

Prerequisite: Applied Mathematics	
Course Objectives:	
1	Introduction to the basic concepts in Statistics
2	Understand concept of data collection & sampling methods.
3	Introduction to Regression, Multiple Linear Regression
4	Draw interference using Statistical inference methods
5	Tests of hypotheses
Course Outcomes:	
1	Recognize the need of Statistics and Quantitative Analysis
2	Apply the data collection and the sampling methods.
3	Analyze using concepts of Regression, Multiple Linear Regression
4	Formulate Statistical inference drawing methods.
5	Apply Testing of hypotheses

Module	Content	Hrs
1	**Introduction to Statistics**	**6**
	Functions – Importance – Uses and Limitations of Statistics. Statistical data–Classification, Tabulation, Diagrammatic & Graphic representation of data	
2	**Data Collection & Sampling Methods**	**6**
	Primary & Secondary data, Sources of data, Methods of collecting data. Sampling – Census & Sample methods –Methods of sampling, Probability Sampling and Non-Probability Sampling.	
3	**Introduction to Regression**	**8**
	Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit –R2 – MAE – MAPE.	
4	**Introduction to Multiple Linear Regression**	**8**
	Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance overall significance of Overall fit of the model, Testing for Individual Regression Coefficients	
5	**Statistical inference**	**6**
	Random sample -Parametric point estimation unbiasedness and consistence - method of moments and method of maximum likelihood.	
6	**Tests of hypotheses**	**5**
	Null and Alternative hypotheses. Types of errors. Neyman-Pearson lemma-MP and UMP tests.	

Textbooks:	
1	Agarwal, B.L. (2006):-Basic Statistics. Wiley Eastern Ltd., New Delhi
2	Gupta, S. P. (2011):-Statistical Methods. Sultanchand&Sons, New Delhi
3	Sivathanupillai, M &Rajagopal, K. R. (1979):-Statistics for Economics Students.
4	Hogg ,R.V. and Craig, A.T.(2006), An introduction to mathematical statistics, Amerind publications.
References:	

1	Arora, P.N., SumeetArora, S. Arora (2007):- Comprehensive Statistical Methods. Sultan Chand, New Delhi
2	Montgomery,D.C. ,Peck E.A, & Vining G.G.(2003). Introduction to Linear Regression Analysis. John Wiley and Sons,Inc.NY
3	Mood AM, Graybill FA, and Boes, D.C.(1985), Introduction to the theory of statistics, McGrawhill Book Company, New Delhi.
4	Kapur, J.N. and Saxena,H.C.(1970), Mathematical statistics, Sultan Chand & company, New Delhi..

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Lab Code	**Lab Name**	**Credit**
CSL601	**System Programming and Compiler Construction Lab**	**1**

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture	
Lab Outcomes: At the end of the course, the students will be able to	
1	Generate machine code by implementing two pass assemblers.
2	Implement Two pass macro processor.
3	Parse the given input string by constructing Top down/Bottom-up parser.
4	Identify and Validate tokens for given high level language and Implement synthesis phase of compiler.
5	Explore LEX & YACC tools.

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Implementations of two pass Assembler.
2	Implementation of Two pass Macro Processor.
3	Implementation of Lexical Analyzer.
4	Implementation of Parser (Any one).
5	Implementation of Intermediate code generation phase of compiler.
6	Implementation of code generation phase of compiler.
7	Study and implement experiments on LEX, YACC.

Reference Books:	
1	Andrew W. Appel Princeton University. Jens Palsberg *Modern Compiler. Implementation in Java*, Second Edition. Purdue University. CAMBRIDGE University press @2002.
2	Charles N. Fischer, Richard J. LeBlanc *Crafting a compiler with C , pearson Education 2007*

Term Work:	
1	Term work should consist of experiments based on suggested experiment list.
2	Journal must include at least 2 assignments on content of theory and practical of "System Programming and Compiler Construction"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	The distribution of marks for term work shall be as follows: Laboratory work (experiments/case studies): ....(15) Marks. Assignment: .... (05) Marks. Attendance .... (05) Marks TOTAL: .... (25) Marks.
Oral & Practical exam will be based on the above and CSC601 syllabus.	

Lab Code	Lab Name	Credit
CSL602	**Cryptography & System Security Lab**	**1**

Prerequisite: Computer Network	
Lab Objectives:	
1	To apply various encryption techniques
2	To study and implement various security mechanism
3	To explore the network security concept and tools
Lab Outcomes: At the end of the course, the students will be able to	
1	apply the knowledge of symmetric and asymmetric cryptography to implement simple ciphers.
2	explore the different network reconnaissance tools to gather information about networks.
3	explore and use tools like sniffers, port scanners and other related tools for analysing packets in a Network.
4	set up firewalls and intrusion detection systems using open-source technologies and to explore email security.
5	explore various attacks like buffer-overflow and web application attack.

Suggested List of Experiments	
Sr. No	**Title of Experiment**
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers.
2	Implementation and analysis of RSA crypto system.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, ns lookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools: wireshark,: 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open-source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools
10	Simulate buffer overflow attack using Ollydbg, Splint, Cpp check etc
11	a. Set up IPSEC under LINUX. b. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security
14	SQL injection attack, Cross-Cite Scripting attack simulation
15	Case Study /Seminar: Topic beyond syllabus related to topics covered.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of

	“Cryptography and System Security “
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	The distribution of marks for term work shall be as follows: Lab Performance 15 Marks Assignments 05 Marks Attendance (Theory & practical) 05 Marks

Lab Code	Lab Name	Credit
CSL603	Mobile Computing Lab	1

Prerequisite: Computer Networks	
Lab Objectives:	
1	To learn the mobile computing tools and software for implementation.
2	To understand the security algorithms in mobile networks
3	To learn security concepts
Lab Outcomes: At the end of the course, the students will be able to	
1	develop and demonstrate mobile applications using various tools
2	articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
3	Students will able to carry out simulation of frequency reuse, hidden/exposed terminal problem
4	implement security algorithms for mobile communication network
5	demonstrate simulation and compare the performance of Wireless LAN

Suggested List of Experiments

The softwares like Android Studio, J2ME, NS2, NS3 and any other software which is suitable are recommended for performing the practical.

Sr. No.	Title of Experiment
1	Implementation a Bluetooth network with application as transfer of a file from one device to another.
2	To implement a basic function of Code Division Multiple Access (CDMA).
3	Implementation of GSM security algorithms (A3/A5/A8)
4	Illustration of Hidden Terminal/Exposed terminal Problem. Consider two Wi-fi base stations (STA) and an access point (AP) located along the x-axis. All the nodes are fixed. The AP is situated at the middle of the two STA, the distance of separation being 150 m. [variable]. Node #0 and node #1 are the hidden terminals. Both are transmitting some data to the AP (almost at same rate) at the same time. The loss across the wireless link between each STA and the AP is fixed at 50 dB irrespective of the distance of separation. To study how RTS/CTS helps in wireless networks, 1. No RTS/CTS is being sent. 2. Nodes do exchange RTS/CTS packets. **Compare the no. of packet retransmissions required in both the cases (as obtained in the output) and compare the results.**
5	To setup & configuration of Wireless Access Point (AP). Analyze the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS). Consider BS and AP are static. Find out the maximum distance to which two way communications is possible. Try multiple iterations by adjusting its distance in the code and test it.
6	Study of security tools (like Kismet,Netstumbler)
7	Develop an application that uses GUI components.
8	Write an application that draws basic graphical primitives on the screen.
9	Develop an application that makes use of database.
10	Develop a native application that uses GPS location information.
11	Implement an application that creates an alert upon receiving a message.

12	Implementation of income tax/loan EMI calculator and deploy the same on real devices (Implementation of any real time application)

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “ Mobile Computing”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Useful Links	
1	https://nptel.ac.in/courses/106/106/106106147/
2	https://www.coursera.org/learn/smart-device-mobile-emerging-technologies

Lab Code	**Lab Name**	**Credit**
CSL604	**Artificial Intelligence Lab**	**1**

Prerequisite: Discrete Mathematics, Data Structure	
Lab Objectives:	
1	To realize the basic techniques to build intelligent systems
2	To apply appropriate search techniques used in problem solving
3	To create knowledge base for uncertain data
Lab Outcomes: At the end of the course, the students will be able to	
1	Identify languages and technologies for Artificial Intelligence
2	Understand and implement uninformed and informed searching techniques for real world problems.
3	Create a knowledge base using any AI language.
4	Design and implement expert systems for real world problems.

Suggested List of Experiments (programming in python)	
Sr. No.	**Title of Experiment**
1	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.
2	Assignments on State space formulation and PEAS representation for various AI applications
3	Program on uninformed search methods.
4	Program on informed search methods.
5	Program on Game playing algorithms.
6	Program for first order Logic
7	Planning Programming
8	Implementation for Bayes Belief Network
Note: Any other practical covering the syllabus topics and subtopics can be conducted. The programming assignment for First order logics could be in the form of a mini project	

Term Work:	
1	Term work should consist of a minimum of 8 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Artificial Intelligence”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam: Based on the entire syllabus of CSC604: Artificial Intelligence	

Lab Code	Lab Name	Credit
CSL605	Cloud Computing	2

Prerequisite: Computer Networks

Lab Objectives: The course has following objectives

1 To make students familiar with key concepts of virtualization.

2 To make students familiar with various deployment models of cloud such as private, public, hybrid and community so that they star using and adopting appropriate type of cloud for their application.

3 To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.

4 To make students familiar with security and privacy issues in cloud computing and how to address them.

Lab Outcomes: At the end of the course, the students will be able to

1 Implement different types of virtualization techniques.

2 Analyze various cloud computing service models and implement them to solve the given problems.

3 Design and develop real world web applications and deploy them on commercial cloud(s).

4 Explain major security issues in the cloud and mechanisms to address them.

5 Explore various commercially available cloud services and recommend the appropriate one for the given application.

6 Implement the concept of containerization

Module	Detailed Contents	Hours	LO
01	**Title:** Introduction and overview of cloud computing. **Objective:** To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages.	2	2
02	**Title:** To study and implement Hosted Virtualization using VirtualBox& KVM. **Objective:** To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should have demonstration of creating and running Virtual machines inside hosted hypervisors like VirtualBox and KVM with their comparison based on various virtualization parameters.	2	1
03	**Title:** To study andImplement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. **Objective:** To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.	4	1

04	**Title:** To study andImplement Infrastructure as a Service using AWS/Microsoft Azure. **Objective:** To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.	4	2
05	**Title:** To study andImplement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. **Objective:** To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.	4	2
06	**Title:** To study andImplementStorage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. **Objective:** To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.	4	2
07	**Title:** To study andImplementDatabase as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ MongoDB Lab/ Firebase. **Objective:** To know the concept of Database as a Service running on cloud and to demonstrate the CRUD operations on different SQL and NOSQL databases running on cloud like AWS RDS, AZURE SQL/ Mongo Lab/ Firebase.	2	2
08	**Title:** To study andImplementSecurity as a Service on AWS/Azure **Objective:** To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.	3	4
09	**Title:** To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud. **Objective:** To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.	2	2
10	**Title:** To study and Implement Containerization using Docker **Objective:** To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside local machine or cloud platform.	4	6

11	**Title:** To study and implement container orchestration using Kubernetes **Objective:** To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML,	4	6
12	**Mini-project:** Design a Web Application hosted on public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]	4	3, 5

Sr. No.	Suggested Assignment List (Any two)	LO
1	Assignment based on selection of suitable cloud platform solution based on requirement analysis considering given problem statement	5
2	Assignment on recent trends in cloud computing and related technologies	5
3	Assignment on comparative study of different computing technologies [Parallel, Distributed, Cluster, Grid, Quantum)	5
4	Comparative study of different hosted and bare metal Hypervisors with suitable parameters along with their use in public/private cloud platform	1
5	Assignment on explore and compare the similar type of services provided by AWS and Azure [Any ten services]	5

Digital Material:

Sr. No.	Topic	Link
1	Introduction and overview of cloud computing	https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version-2_2013_June18_FINAL.pdf
2	Hosted Virtualization using KVM	https://phoenixnap.com/kb/ubuntu-install-kvm\
3	Baremetal Virtualization using Xen	https://docs.citrix.com/en-us/xenserver/7-1/install.html
4	IaaS, PaaS, STaaS, DbaaS, IAM and Security as a Service on AWS and Azure	1) AWS https://docs.aws.amazon.com/ 2) MS Azure https://docs.microsoft.com/en-us/azure
5	Docker	https://docs.docker.com/get-started/

6	Kubernetes	https://kubernetes.io/docs/home/

Textbooks:	
1	Bernard Golden, “Amazon Web Services for Dummies”, John Wiley & Sons, Inc.
2	Michael Collier, Robin Shahan, “Fundamentals of Azure, Microsoft Azure Essentials”, Microsoft Press.
3	RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, “Mastering Cloud Computing”, Tata McGraw-Hill Education.
4	Barrie Sosinsky, “Cloud Computing Bible”, Wiley publishing.
5	John Paul Mueller, “AWS for Admins for Developers”, John Wiley & Sons, Inc.
6	Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , “Docker Cookbook - Second Edition”, Packt publication
7	Jonathan Baier, “Getting Started with Kubernetes-Second Edition”, Packt Publication.

Term Work:	
1	Term work should consist of 10 experiments and a mini project.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 50 Marks (Experiments: 15-marks, Mini project (Implementation) 15 marks, Mini Project Presentation & Report [for deployment, utilization, monitoring and billing] 10 Marks, Attendance 05-marks, Assignments: 05-marks)
Oral examination will be based on Laboratory work, mini project and above syllabus.	

Course code	Course Name	Credits
CSM601	Mini Project 2B	02

Objectives	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members and inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature surveys
2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations
4	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. ● The work may result in research/white paper/ article/blog writing and publication ● The work may result in business plan for entrepreneurship product created ● The work may result in patent filing.
7	Gain technical competency towards participation in Competitions, Hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work as a member of a group or as leader
Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.

9	With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work

The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

	Distribution of Term work marks for both semesters shall be as below:	**Marks 25**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1	In the first semester the entire theoretical solution shall be made ready, including components/system selection and cost analysis. Two reviews will be conducted based on a presentation given by a student group. ☐ First shall be for finalization of problem ☐ Second shall be on finalization of proposed solution of problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ☐ First review is based on readiness of building working prototype to be conducted. ☐ Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.

Half-year project:

1	In this case in one semester students' group shall complete project in all aspects including, ☐ Identification of need/problem ☐ Proposed final solution ☐ Procurement of components/systems ☐ Building prototype and testing
2	Two reviews will be conducted for continuous assessment, ☐ First shall be for finalization of problem and proposed solution ☐ Second shall be for implementation and testing of solution.

Mini Project shall be assessed based on following points

1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement gathering via SRS/ Feasibility Study
3	Completeness of methodology implemented

4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	**Verification and validation of the solution/ Test Cases**
11	**Full functioning of working model as per stated requirements**
12	**Technical writing /competition/hackathon outcome being met**

In one year project (sem V and VI), first semester evaluation may be based on first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.
In case of half year projects (completing in VI sem) all criteria's in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

Revised Syllabus as per
A.A.U. received Gmail dt. 17.1.2020

University of Mumbai

No. UG/ 44 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/249 of 2010 dated 12th August, 2010 relating to the revised syllabus of Fourth Year (Sem.VII & VIII) of the B. E. Degree Course in branch of Civil Engineering.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 11th April, 2019 have been accepted by the Academic Council at its meeting held on 15th April, 2019 **vide** item No. 4.51 and that in accordance therewith, the revised syllabus as per the (CBCGS) for the B.E. Civil Engineering (Sem. VII & VIII) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
9th July, 2019

(Dr. Ajay Deshmukh)
REGISTRAR

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.51/15/04/2019

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No. UG/ 44 -A of 2018-19 MUMBAI-400 032 9th July, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

AC 15/04/2019
ITEM NO: 4.51

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Civil Engineering

Second Year with Effect from A.Y. 2017-18

Third Year with Effect from A.Y. 2018-19

Final Year with Effect from A.Y. 2019-20

As per Choice Based Credit and Grading System

with effect from the A.Y. 2016–17

Dean, Faculty of Science and Technology

Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development. Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, semester-based credit and grading system is also introduced to ensure quality of engineering education. Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scales to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017- 18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Dean(I/c) Faculty of Science and Technology,

Member - Academic Council,

University of Mumbai, Mumbai

Chairman

Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education in the process of curriculum development. As the Chairman, Board of Studies in Civil Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The Program Educational Objectives finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome-based education.

I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. K. Ukarande

Chairman, Board of Studies in Civil Engineering,

University of Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai
Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai
Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (In Hrs.)				
		Test 1	Test 2	Avg						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract**	**Tut.**	**Theory**	**Practs**	**Tut.**	**Total**
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					**Term Work**	**Pract.**	**Oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (InHrs.)**				
		Test1	**Test2**	**Avg**						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course ‘Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course ‘Business and Communication Ethics (CE-C 507)’ will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying CE-DLO5062: Advanced Concrete Technology CE-DLO5063: Building Services and Repairs CE-DLO5064: Advanced Structural Mechanics	CE-DLO6061: Advanced Construction Equipment CE-DLO6062: Traffic Engineering and Management CE-DLO6063: Ground Improvement Techniques CE-DLO6064: Advanced Structural Analysis

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester -VII)

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Practs.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	--	2	4		2	6
CE-C703	Water Resource Engineering -II	3	--	2	3	--	2	5
CE-DLO704X	Department Level Optional Course-III	3	--	2	3	--	2	5
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**8**	**6**	**17**	**4**	**6**	**27**

Subject Code	**Subject Name**	**Examination Scheme**								
		Theory					**Term Work**	**Pract**	**Oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (InHrs.)**				
		Test1	**Test 2**	**Avg**						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 705), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester- VIII)

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Practs**	**Tut.**	**Theory**	**Practs**	**Tut**	**Total**
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	2	--	4	1	-	5
CE-C802	Construction Management	4	2	--	4	1	-	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	--	3	--	--	3
CE-P804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**18**	**-**	**15**	**9**	**-**	**24**

Subject Code	**Subject Name**	**Examination Scheme**								
		Theory					**Term Work**	**Pract**	**Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (In Hrs.)**				
		Test1	**Test 2**	**Avg**						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	--	--	--	100
CE-P804	Project – Part II	--	--	--			50	--	50#	100
Total		**80**	**80**	**80**	**320**		**125**		**125**	**650**

# The oral examination for the Project- Part II (CE-P 804) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.

(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.

(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Applied Hydrology and Flood Control

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester-VII

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 701	**Quantity Survey, Estimation & Valuation**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Any structure, i.e., building, bridge, dam etc. consists of various building materials. Due to rise in the cost of materials, the structure has to be designed so that it is safe, serviceable and economical. Without proper design and estimation, it may lead to the increase in cost of construction and it further affects the economical aspect of the structure. A prior knowledge of various building materials is required for the construction and it controls the cost of the structure, save wastage of labour-hours and eventually helps in giving the correct amount required and quantity of various materials required. It also helps in scheduling of men, materials and machine to be used in the project at stages. The scope of the subject includes estimating, costing, analysis of rates, specification, valuation, tender and contracts etc.

Objectives

- To read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.
- To study the various methods of detailed and approximate estimates.
- To emphasize the importance of relevant IS: 1200- 1964 codes and relevant Indian Standard specifications, taking out quantities from the given requirements of the work, and drafting specifications.
- To conduct a material and labour survey to understand the current market rates for the various materials required for construction and the different categories of labour required.
- To perform the rate analysis for various items: standard and non-standard and the use of DSR in this process.
- To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.

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Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Hrs**
I.	**Introduction**		**04**
	1.1	Importance of Course	
	1.2	Measurement systems for various items of civil engineering structures.	
	1.3	Units of measurement of various items of works	
	1.4	I.S1200	
II.	**Specifications & Rate Analysis**		**09**
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of various items of work etc	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labour output ,District Schedule of Rates(DSR) Rate analysis of important items of construction works.	
III.	**Estimates**		**14**
	3.1	**Approximate Estimate** Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, Technical sanction, Contingencies, Work charged establishments etc.	
	3.2	**Detailed Estimate** Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Methods of taking out quantities such as long wall & short wall method, Centre line method etc Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structural elements as per code IS2502.Preparation of detailed estimate of R.C.C framed structures	
IV.	**Estimation of Earthwork for Roads & Canals**		**06**
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula, Spot level method etc. & numericals based on methods. Mass haul diagram & its necessity, Terms like lead & lift etc.	
V.	**Tenders & Contracts**		**09**
	5.1	**Tenders** Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & Opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	**Contracts** Definition, basic forms such as Valid, void & voidable contract. General types of contract with their suitability, conditions of contract	
	5.3	**Dispute resolution methods** Causes of disputes & disputes resolution methods such as litigation, mediation & arbitration	

VI.	**Valuation**		**10**
	6.1	Difference between cost, price & value. Types of value, Valuation & its purposes. Various terms such as depreciation, sinking fund, capitalized value, years purchase etc. Methods for calculating depreciation of building	
	6.2	Methods of valuation such as Rental method, land & building method, Belting method etc.	
	6.3	Freehold Properties, Leasehold Properties, Easement rights	
	6.4	Numericals based on valuation	

Contribution to Outcomes

On completion of the course, the learners will be able to:

- **Apply** the measurement systems to various civil engineering items of work.
- **Draft** the specifications for various items of work & determine unit rates of items of works
- **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures by referring drawings.
- **Assess** the quantities of earthwork &**construct** mass haul diagrams.
- **Draft** tender notice &**demonstrate** the significance of the tender as well as contract process.
- **Determine** the present fair value of any constructed building at stated time.

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** based on computation of quantities of various items of work by referring drawings.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the modules shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work shall consist of the following:

- At least **eight** assignments based on entire syllabus

- Detailed estimate of any **Three** of the following with the required material survey for the same.

- Single Storied building (RCC)
- Road work
- Load bearing structure
- Cross drainage work

- Valuation report in a standard format of the Government/ Private company/Firm.

The use of quantity survey software and the use of worksheets/databases while solving some of the afore-mentioned assignments is desirable.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weight age of marks shall be given for different components of the term work.

Assignments : 20 Marks **Attendance : 05 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.,* Kolkata.

2) Building and Engineering Contracts: *Patil, B. S.,* University Press, Hyderabad.

3) Estimating and costing: *Datta, B. N.,* UBS Publications

4) Relevant Indian Standard Specifications, BIS Publications

5) World Bank approved contract documents

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 702	**Theory of Reinforced Concrete Structures**	**06**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**-**	**02**	**04**	**-**	**02**	**06**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Working stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e. steel and the concrete. The limit state method (LSM) is based on the statistical probability which provides the rational solution to the design problem. The philosophy lies behind LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The subject involves the application of working stress and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

- To develop the clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using (WSM) working stress method and (LSM) limit state method.
- To study the various clauses of IS: 456-2000 and its significance in the RCC design.
- To apply the concepts of LSM in the analysis and design of beams, slabs and columns.
- To study the concept of Serviceability and durability for deflection and crack width calculation in RCC structures.
- To study the concept of reinforced concrete footing design subjected to axial load and moment.
- To develop the concept of design using ready charts and curves for column subjected to axial load and moments.

Detailed Syllabus

Module	Contents	Hrs
I.	**Working Stress Method** Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS-456-2000; stress- strain curve of concrete and steel, characteristics of concrete steel reinforcement. Concept of balanced, under reinforced and over reinforced sections. Analysis design of singly reinforced and doubly reinforced rectangular beams for flexure, shear by WSM, Analysis and design of Cracked and un-cracked RCC column sections by WSM	**12**
II.	**Limit State Method** Introduction to limit state method of design as per IS-456-2000; concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	**03**
III.	**Limit State of Collapse – Flexure, Shear, Bond and Torsion** Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing. Deflection and crack width calculation for RCC members.	**15**
IV.	**Design of Slabs using LSM:** Design of one way, one way continuous slab and two way slabs with all end conditions as per IS-456-2000.	**06**
V.	**Limit State of Collapse – Compression:** Limit state of collapse compression for short and slender column. Members subjected to combined axial and uni-axial as well as biaxial bending. Development of interactive curves and their use in column design.	**08**
VI.	**Design of Foundations:** Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing. Design of Raft foundations (No numerical to be asked on raft foundations in the exam)	**08**

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

- Understand the pros and cons of the WSM and LSM.
- Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
- Carry out analysis and design of various elements of the reinforced concrete structures such as beam, slab, column, footings using the concept of Limit state method.
- Understand and the use of readymade design curves from Special publications of Bureau of Indian standards.

Theory Examination:-

- **Use of IS:456-2000 shall be allowed in the examination.**
- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each modules/ sub-modules contents thereof. At least one numerical on raft foundation shall be included in assignments.

Distribution of Term-work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Mark

Recommended Books:-

1. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Jain A. K*, Nemchand and Bros., Roorkee
3. Limit State Design – Reinforced Concrete: *Shah and Karve,* Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: *Arthur, P. D. and Ramakrishnan, V.,* Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: *Sinha& Roy*, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve,* Structure Publications, Pune.
8. Reinforced Concrete Design: *Wang, C. K., Salmon, C. G., and Pincheira, J. A,*
   John Wiley (2007), 7th Edition.

9. Reinforced Concrete Fundamentals: *Ferguson, P. M., Breen, J. E., and Jirsa, J. O.*, John Wiley & Sons (1988) 5th Edition.
10. RCC Design (WSM and LSM): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
11. Limit State Design of Reinforced Concrete (as per IS: 456-2000): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
12. Design of RCC structural Elements (RCC Vol-I): *Bhavikatti, S. S.*, New Age International Publications.
13. Reinforced Concrete: *Syal and Goel*; Wheeler Publishers.
14. Relevant IS Codes: BIS Publications, New Delhi.
15. Reinforced Concrete Design: *Pillai,S.U.*and*Menon,Devdas*, Tata Mc-Graw Hill Publishing House, New Delhi.
16. Reinforced Concrete Designby S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
17. Theory of Reinforced concrete structures by N. Subramanian , Oxford University Press.

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 703	**Water Resources Engineering II**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**-**	**02**	**03**	**-**	**02**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This subject provides necessary knowledge about design of gravity dams, earthen dams, energy dissipaters, canal headwork's, and canal structures. This subject is also useful with respect to facts, concepts, principles and procedures related to canal design, canal lining, cross drainage works and water logging. Further students will be able to plan and execute the construction of these structures.

Objectives

- To understand different types of dams and its suitability to a particular region.
- To study design consideration of earthen dams
- To study various types of Spillways
- To understand the importance of silt theories for design of irrigation channels
- To study the classification of canals and design of canal system.

Detailed Syllabus

Module	Topics	Hrs
I	**Gravity dams**	**08**
	Definition, typical cross section, forces acting on gravity dam, modes of failure and structural stability analysis, profile of dam- elementary and practical profile, low and high gravity dam, design consideration and fixing of section of dam, methods of design, construction of galleries in dams, types of joints, temperature control in concrete dams, foundation treatment, Arch dams, types of arch dams	
II	**Earth and rock fill dams:**	**06**
	Types of earth dams, method of construction, causes and failures of earth dams, design criteria, selecting suitable preliminary section, seepage line for different conditions and its location, seepage control through embankment and through foundations, Swedish circle method with pore pressure, details of	

	construction and maintenance, types of rock fill dams, stability analysis, advantages	
III	**Spillways and flood control works:**	06
	Introduction, location of spillway, design consideration of main spillway, controlled and uncontrolled spillway, types of spillways, design principles of ogee spillway. Chute spillway. Siphon spillway and shaft spillway, energy dissipation below overflow and other types of spillways, design of bucket type energy dissipater and stilling basin, flood mitigation reservoirs. Crest gates, types, advantages, design of radial gate, outlet works through dams, intake structures.	
IV	**Irrigation Channels (Silt Theories)**	07
	Kennedy's theory, Kennedy's methods of channel designs silt supporting capacity according to Kennedy's theory. Drawbacks in Kenned' % theory Lacey's regime theory, Lacey's theory applied to channel design. Comparison of Kennedys and Lace 'S theory defects in Lacey's theory. Introduction to Sediment transport in channels.	
V	**Canal Head works and Distribution System**	06
	Canals: Classification, canal alignment, canal losses, estimation of discharge, cross sections of irrigation canals, maintenance of irrigation canal, canal lining, economics of canal lining, water logging, effect of water logging, remedial measures.	
VI	**Canal structures**	06
	Canal falls, types of canal falls, canal escapes, types, canal head regulators, cross regulators, canal outlets and its types cross drainage works and types of cross drainage works.	

Course Outcomes

On completion of this course the student will be able to:

- Design the section of gravity dams, earth and rockfill dams, arch dams and buttress dams.
- Design spillways and energy dissipaters.
- Apply silt theories to design irrigation canals.
- Explain various types of canals and its maintenance.
- Explain different cross drainage works of a canal system.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.

2. The first question will be compulsory and will have short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. The students will have to attempt any three questions out of remaining five questions.

5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof further. It is advisable to arrange dam visit.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

- 75%- 80% : 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Irrigation and Water Power Engineering: *B.C. Punmia, PandeB.B.Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,*Ane Books Pvt. Ltd.ISBN,9789383656899.
3. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.
6. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand
7. Engineering for Dams, Vol. I to III:*Crager, Justin and Hinds*, John Wiley
8. Design of Small Dams: USBR.
9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross.
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7041	**Department Level Elective: Pre-stressed Concrete**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Avg**						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Rationale

The course is aimed to make the student to be aware of highly mechanized technology in civil engineering construction and to develop the basic understanding of pre-stressed concrete which is used in a wide range of building and civil structures. A Pre-stressed Concrete section improves performance/efficiency, reduces structural thicknesses, and material savings compared with simple reinforced concrete sections. Typical applications of pre-stressed concrete include high rise buildings, residential slabs and bridge structures etc.

Objectives

- To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of pre-stressed section over R. C. C. as a civil engineer.
- To make the candidate to understand the analysis of Pre-stressed Concrete sections and losses in pre-stress.
- To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

Detailed Syllabus		
Module	**Sub module/Contents**	**Hrs**
I	**Introduction to pre-stressed concrete and analysis of pre-stressed concrete section :** Basic concept and general principles, materials used and their properties, methods, techniques and systems of pre-stressing	**04**
II	**Analysis of Pre-stressed Concrete Section:** Loading stages, stress method, load balancing method and internal resisting couple method of analysis, cable profiles, pressure line, kern points, choice and efficiency of sections	**10**
III	**Losses in pre-stress:** Loss of stresses due to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction	**06**
IV	**Analysis of Pre-stressed Concrete Members in Limit State of Serviceability deflection:** Short time and long time deflection of uncracked members, permissible limits	**05**

V	**Analysis and Design of Pre-stressed Concrete Members for Limit State of Collapse Shear** Calculation of principle tension, permissible principle tension, Analysis and Design of members in shear (sections uncracked in flexure)	**05**
VI	**Analysis and Design of Pre-stressed Concrete Members for Limit State of Collapse Flexure and Serviceability Cracking** General philosophy of design, Analysis and design of members in flexure, permissible stresses in concrete and steel at different stages, suitability of section, safe cable zone	**09**

Contribution to outcome

On successful completion of the course, the students shall be able:

- To understand the basic concept, application and behaviour of pre-stressing over that of the RC structure.
- To have knowledge of modern engineering tools necessary for pre-tensioning and post-tensioning technology.
- To evaluate various losses occurring in pre-stressed concrete structure
- To analyze the various pre-stressed components of the structure and design the same for flexure as well as shear using relevant IS Code.
- To analyze pre-stressed concrete members for limit state of serviceability for cracking and deflection

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus, site visit and the term work.

Site Visit/ Field Visit:

The students shall visit the site where the construction of structure using pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

Term Work:

The term work shall consist of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems/ questions on each modules/ sub-modules and contents thereof further. The report of the site visit/ field visit shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled report of the site visit /field visit and the minimum passing marks to be obtained by the student.

The following weightage of marks shall be given for different components of the term work.

Assignments: 15 Marks
Report of the Site Visit/Field Visit: 05 Marks
Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Prestressed Concrete*: N. Krishna Raju*, McGraw Hill, New York.
2. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: *Sinha, N.C.*and*S.K. Roy*, S.C. Chand and Company.
4. Prestressed Concrete Structures: *Dayaratnam, P.*, Oxford andIBH
5. Design of Prestressed Concrete Structures: *T.Y.Lin*and*N.H. Burns*, John Willey, New York.
6. Design of Prestressed Concrete: *Nilson Arthur*, McGraw Hill Book Company.
7. Prestressed Concrete Vol—I*: IY.Guyon*, Contractors Record, London.
8. Prestressed Concrete*: S. Ramamurtham*, DhanpatRaiandSon's
9. Relevant latest IS codes (IS:1343-2012)

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7042	**Department Level Elective: Solid Waste Management**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Teamwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Average**						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Rationale

This course will be of interest to those wishing to understand the principles and techniques of solid waste management, including the legislative, environmental, economic and social drivers. Students will be introduced to the selection and design of appropriate methods of storage, collection, transfer, treatment and disposal in both industrialized and developing countries. The course also provides the opportunity to visit recycling facilities and disposal sites to better understand links between theory and practice.

Objectives

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.
- To provide knowledge of different types of sources, sampling and characteristics of solid waste.
- To impart knowledge and skills in the collection, storage, transport and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipments.
- To fully appreciate the current practices available and implement the systems available in solid waste management.
- To be aware of the significance of recycling, reduce, reuse of solid wastes and also to impart students with the skill of design and operation of disposal system based on latest technology.
- To provide students prerequisite knowledge necessary for higher studies and research in the field of Solid waste management.

Module	Sub Modules/Contents	Hrs
I	**Introducing Municipal Solid Waste Management** Overview: problems and issues of solid waste management - Need for solid waste management-Functional elements such as waste generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.	**03**
II	**Generation and characteristics of waste** Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes	**03**
III	**Waste collection, storage and transport** Collection and storage of municipal solid waste; Methods of collection - House to House collection -collection routes; on site storage methods-materials used for containers -Recycling and Reuse of waste -Need for transfer and transport; transfer station-selection of location, operation and maintenance; transportation Methods-manual, Mechanical methods with or without compaction, economy in transportation of waste optimization of transportation routes.	**10**
IV	**Waste processing techniques** Processing techniques-biological and chemical conversion technologies – composting and its methods, Vermi-composting, mechanical composting, In vessel composting, incineration, pyrolysis, gasification.	**04**
V	**Disposal of Solid Waste** Segregation, Volume reduction at source, recovery and recycle; dumping of solid waste-sanitary waste- sanitary landfills-site selection-design and operation of sanitary landfill - leachate and landfill gas management-landfill closure and environmental monitoring-landfill remediation; Municipal solid waste in Indian conditions, legal aspects of solid waste disposal, Plastic waste disposal.	**10**
VI	**Types of Solid Waste** **Industrial** Waste products during manufacturing and packing, operation of pollution control facilities, generation, and minimization at source, recycling, disposal. **Hazardous waste** Definition, sources, hazardous characteristics, management, treatment and disposal **Electronic waste** Waste characteristics, generation, collection, transport and disposal **Biomedical waste** Definition, sources, classification, collection, segregation- Color coding, treatment and disposal.	**09**

Contribution to outcomes

On completion of this course, the students will be able to understand the various methods of disposal of solid waste. They will have better understanding of the nature and characteristics of solid waste and regulatory requirements regarding solid waste management and further they will have an ability to plan waste minimization. Besides, they will be prepared to contribute practical solutions to environmental problems in our society.

After the completion of the course the student should be able to

- Explain generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.
- Understand the characteristics of different types of solid waste and the factors affecting variation.
- Identify the methods of collection, storage and transportation of solid waste.
- Suggest suitable technical solutions for processing of wastes.
- Ability to plan waste minimization and disposal of municipal solid waste.
- Ensure the safe handling and treatment of Hazardous, Electronic and Biomedical waste.

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments, Tutorials including the site visit report.

Mini Project- Student should perform activities related to solid waste management at institute level forming groups 4 to 5 students, Report of the activity should be part of term work

Site Visit: The students will visit landfilling /composting site in the nearby vicinity and prepare detailed report thereof. This report will form a part of the term work.

Term Work:-

The Term Work shall comprise essentially of the following assignments covering the entire syllabus. The report of the site visit/ field visit and mini-project shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

The following weightage of marks shall be given for different components of the term work.

a. Report (on any industrial/hazardous/municipal solid waste/site visit): 05 Marks
b. Seminar/Mini Project : 05Marks
c. Attendance : 05 Marks
d. Assignments and Tutorials :10 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications.
4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, Rakesh Johri, The Energy and Resources Institute.
6. Biomedical Waste Management in India: Jugal Kishore and G. K. Ingle, Century Publications.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7043	**Department Level Elective: Pavement Subgrade and Materials**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Average**						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Rationale

Highway and airways mode of transportation contributes to the economical, industrial, social and cultural development of any country. For the design and construction of highway and airfield, it is imperative to know the properties of the materials such as soil, aggregates and bitumen used in the construction of pavements. The various tests are required to be conducted to evaluate the properties of these materials for the scientific design of the pavements and economic utilization of the different materials. The course also deals with the soil survey, stresses in soil and various ways and means of improving the soil and implementing techniques of improvement. The course also deals with the various surface and sub-surface drainage.

Objectives

- To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards.
- To study the significance of the soil subgrade along with its functions.
- To study the soil classification for highway engineering purpose as per different classification system.
- To understand the concept of stresses in soil.
- To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
- Learn bituminous mix and cement concrete mix designs
- Learn basic principles of superpave technology of bituminous mixes

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I.	**Soil: Soil-Classification methods, Tests:**CBR test, effect of lateral confinement on CBR and E value of Subgrade soil, Consistency, Engineering Properties and Modulus of sub-grade reaction ofsoil, estimation of modulus of subgrade reaction, Static and cyclic plate load test, correction for plate size, correction for worst moisture content. Soil classification as per HRB.	08
II.	**Stresses in Soil:** Theories of elastic and plastic behavior of soils, Cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for testing , Relation for Moisture content and Dry Density of Stabilized mixes, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes.	06
III.	**Aggregate:** Classification, requirements, Blending of aggregates, Importance of aggregate shape factor in mix design. Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials),	04
IV.	**Bitumen, Tar and Bituminous Mix Design**; requirements, criteria for selection of different binders, Temperature susceptibility, Bituminous emulsion and Cutbacks, fillers, extenders Polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance.	08
V.	**Bituminous Mix Design:** selection of different grade of bitumen, skid qualities, types of bituminous surfaces, bituminous mix design, Marshall Stability test, design aspect of paving concrete.Experimental characteristics of road aggregate.	06
VI.	**Introduction to Super pave Technology:** Methods of selection of suitable ingredient for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test. Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method.	07

Contribution to Outcomes

On the successful completion of the course, the students shall be able to:

- Understand the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material.
- Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
- Understand the characterization of different paving materials along with the tests to be conducted on these materials.
- Know the various ground improvement methods.
- Understand subgrade soil strength in terms of standard engineering parameters.
- Application of basic principles of mix design of cement concrete and bituminous mixes

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

Term Work:

The term-work shall comprise of the neatly written report comprising of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ two questions on each modules/ sub-modules and contents thereof further.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work which will comprise of the report on assignments. The final certification and acceptance of term-work warrants the satisfactory and the appropriate completion of the termwork; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

Assignments : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.* , John Wiley and Sons, Inc., New York.
2. Concrete Roads: *HMSO*, Road Research Laboratory, London.
3. Highway Engineering: *Khanna, S.K., Justo, C,E.G. and Veeraragavan, A.*,Nem Chand and Brothers, Roorkee (10th Revised Edition, 2014)
4. Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B.Lal*, Khanna Publishers, New Delhi.
5. Highway Engineering, *Sharma, S.K.*, S. Chand Technical Publishers, New Delhi (3rd Revised Edition, 2013).
6. Principles of Transportation and Highway Engineering: *Rao, G.V.* , Tata Mc-Graw Hill Publications, New Delhi

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7044	**Department Level Elective: Structural Dynamics**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Avg.**						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Course Objective

- To expose the students to understand the basic theory of structural dynamics, structural behaviour under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.
- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete Two DOF systems,
- To study the modal analysis of Two DOF systems and analysis of systems with distributed mass for continuous system.

Details Syllabus

Module	Contents	Hrs
I	**Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.** Static vs. Dynamic loads. Different types of dynamics loads	4
II	**Introduction to single Degree of freedom (SDOF) Systems.** Undamped vibration of SDOF system natural frequency and period of vibration Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor. Response of structure subjected to General dynamic load, Duhamel's Integral Numerical Evaluation of Dynamics Response of SDOF system. Equivalent stiffness of spring in series and parallel	8

III	**Introduction to vibration isolation**. Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	**4**
IV	**Lumped mass multi-degree of freedom (Two DOF) system, coupled and uncoupled system** Direct determination of frequencies of vibration and mod shape. Orthogonality principle. Vibration of Two DOF systems with initial conditions Approximate method of determination of natural frequencies of vibration and mode shapes – Energy methods	**9**
V	**Earthquake analysis – Introduction.** Seismicity of a region, causes of earthquake Intensity of earthquake, Richter Scale, Measurement of Earthquake ground motion, Seismogram, construction of seismograph Application of modal analysis concept to seismic disturbance, Introduction to Response spectrum method.	**8**
VI	**I.S code provisions for seismic analysis of buildings.** Approximate method of earthquake analysis– Seismic co-efficient method and its limitation Introduction to time history analysis.(6)	**6**

Contributions to Outcomes

The students will be able to

- Understand the difference between static and dynamic loads and analysis.
- Evaluate the response of SDOF and Two DOF systems to different types of dynamic loads including ground motions.
- Understand the basics of random vibrations and the application of this concept
- Analyze Linear SDOF systems.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-module content thereof further. There shall be theory questions as well.

Distribution of Term-work Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Recommended Books:-

1. Craig R.R.: 'Structural Dynamics-An Introduction to Computer Methods',*John Wiley and Sons.*
2. Anil K. Chopra: 'Dynamics of Structures', *Prentice Hall India Pvt. Ltd.*
3. Cloguhand Penzein: 'Dynamics of Structures'*TataMc-Graw Hill Pvt. Ltd.*
4. John M. Biggs: 'Structural Dynamics',*TataMc-Graw Hill.*
5. Mario Paz: 'Structural Dynamics Theory and Computation', *CBS Publisher.*

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7045	**Department Level Elective: Applications of Geographic Information Systems & Remote Sensing**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**--**	**02**	**03**	**--**	**02**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg.**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Geographic Information Systems & Remote Sensing Applications provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret date to understand relationships, patterns and trends. In this subject, the students get acquainted with the detailed study of GIS & Remote sensing. Data models of spatial and non-spatial information are also explained. An overview on digitizing, editing and structuring of map data is also provided for error detection, correction and appropriate topology creation. Digital Elevation Models (DEM) and their needs are also incorporated along with the applications of Remote Sensing and GIS. Solution can be provided for Various Civil Engineering problems using Integration GIS-GPS & Remote Sensing Techniques.

Objectives

- To study principles of physics of Electromagnetic radiation as applied to remote sensing.
- To learn the GIS data & its processing using Softwares
- To get acquainted with GPS Satellite & their segments
- To understand the GIS & RS Applications in various fields of Civil Engineering

Module	Content	Hrs
I	**Remote sensing (RS):** Introduction, physics of remote sensing- electromagnetic radiations and their characteristics, thermal emissions, multi-concept in remote sensing, remote sensing satellites and their data products, sensors and orbital characteristics, spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation- visual interpretation, concept of fcc, digital image processing- digital image and its characteristics, satellite data formats, image rectification and restoration, image enhancement- contrast manipulation, spatial feature manipulation, multi-image manipulation.	**8**

II	**Geographical Information System (GIS):** History, Introduction, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS Commercially available GIS hardware and Software Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, pre-processing of data rectification and registration , interpolation techniques, introduction to GIS softwares (Arc GIS, QGIS, Gram++, etc.)	**8**
III	**Global Positioning System (G.P.S) :** G.P.S. Segments: Spaces Segment, Control Segment, User Segment Features of G.P.S. Satellites, Principle of Operation Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S., Kinematics of G.P.S. G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co-ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights Applications of G.P.S	**5**
IV	**Application of G.I.S.& R.S. in Water Resources & Environmental Studies:** Site selection of Hydraulic Structures, Surface water delineation, surface keys for subsurface water, Steps in water investigations of the area, Water management	**6**
V	**Application of G.I.S.& R.S. in Infrastructure Management;** Role of GIS in Town Planning, Urban Transport Planning, Underground Infrastructure Management	**6**
VI	**Application of G.I.S.& R.S in Disaster Management :** RS and GIS applications for disaster vulnerable zones, fire hazards, flood and storm water inundations, earthquake impact assessment, post Tsunami/ cyclone damage assessment.	**5**

Contribution to Outcomes

After completion of course, student will be able to:

- Explain the principles of physics of Electromagnetic radiation as applied to remote sensing.
- Describe Spatial and non-spatial database of geographic information system
- Demonstrate the GPS Satellites & their Segments.
- Apply the GIS & RS techniques in Urban Planning, Water Resources & Environmental Management.
- Integrate the GIS-GPS & RS techniques for Infrastructure Management
- Illustrate applications of GIS& RS in Disaster Management

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work will comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and /or questions on each sub-modules and contents thereof further

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weight age of marks shall be given for different components of the term work.

Assignments : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Introduction to Geographic Information Systems: Kang-Tsung Chang,TataMcGrawHill.
2. Text book on Remote Sensing –C.S. Agrawal and P.K.Garg,Wheeler Publishing, New-Delhi.
3. G.I.S- Anji Reddy, publishers- MGH.
4. GIS, Spatial Analysis, and Modeling: Maguire, D., M.Batty,andM.Goodchild.2005. ESRIPress.
5. Remote sensing in Civil Engineering – T. J. M. Kennie and M. C. Mathews, Surry University press, London
6. Principles of Remote Sensing- P.N.Patel and Surendra Singh, Scientific Publishers, Jodhapur.
7. Remote Sensing and Image Interpretation: Lillesandand Kiefere:, JohnWiley,1987.
8. Global Positioning System: Signals, Measurements, and Performance, Pratap Misraand Per Enge (2nd Ed.), 2006.
9. Introduction to Geomatics –QGIS user guide – Mr.C.V. Nishinkanth, Mrs.Annu Nishinkanth, Dr S S Vasudevan, Dr P Ramkumar

10. Fundamental of Remote sensing: George Joseph, Universities Press Publications.
11. Remote Sensing and GIS, Basudeb Bhatta, Publisher: Oxford University Press, India, Latest Edition

Semester VII		
Subject Code	**Subject Name**	**Credits**
CEC-DLO7046	**Foundation Analysis and Design**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**-**	**02**	**03**	**-**	**02**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Objectives

- To study the bearing capacity and settlement of shallow foundations and To understand the design concepts for shallow foundations including strip and raft foundations
- To study the estimation of vertical stresses in soil
- To study different types of well foundations
- To study the load carrying capacity of pile and design of under reamed piles
- To study Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils and to analyse braced cuts
- To learn different types of machine foundations and understand the design philosophy; and carry out the design thereof.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	**Estimation of stresses in soils:** Boussinesque and Westergaard's theories, Newmark Chart, Practical applications.	**06**
II	**Shallow Foundation**: Basic requirements of foundation, types and selection of foundation, design of shallow foundations by Terzaghi's and IS code method; total settlement analysis including elastic settlements; Structural design of strip and raft foundation.	**07**
III	**Pile Foundation**: Introduction, Necessity of piles, Types of pile foundation, load carrying capacity of single pile and pile in group, , group efficiency, group settlements, design of single pile and pile cap, design of under-reamed pile foundation	**06**
IV	**Floating Foundation and Well Foundation:** Floating Foundation- Introduction, Floatation, bottom elastic heave, Design of floating foundation on piles, Well Foundation- Introduction, forces acting on well foundation.	**06**
V	**Sheet piles and Braced cuts:** Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils: lateral earth pressure diagram,	**08**

	computation of embedment depth. Difference in open cut and retaining wall theories, apparent earth pressure diagram, Average apparent earth pressure diagram for cohesion-less and cohesive soils. Estimation of strut loads in braced cuts placed in cohesion-less and cohesive soils.	
VI	**Machine Foundations:** Introduction, Dynamic soil properties, types of machine vibrations, basic principal of machine foundation.	**06**

Contribution to outcomes

- On successful completion of the course, the learner shall have an: 1. Ability to identify, formulate and solve geotechnical engineering problem.
- Ability to design a suitable foundation system from economic and safe aspects
- Ability to design machine foundations
- Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.
- Ability to understand design of sheet pile
- Ability to analyze vertical stresses developed in soil and used in practical problems

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments, Tutorials.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

The following weightage of marks shall be given for different components of the term work.

- Attendance : 05 Marks

- Assignments and Tutorials :20 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Bowels J.E.: ‘Analytical and Computer Methods in Foundation’, *McGraw Hill Book Co. New York, 1974*
2. Das, B. M.: ‘Geotechnical Engineering Handbook’, *J. Ross Publishing, 2010*
3. Verghese, P. C.: ‘Foundation Engineering’*, PHI Learning Private Limited, Delhi, 2012*
4. Verghese, P. C.: ‘Design of Reinforced Concrete Foundations’, *PHI Learning Private Limited, Delhi, 2011*
5. N. Subramanian: ‘Reinforced Concrete Structures’, *Oxford University Press, 2013*
6. Alam Singh: ‘Soil Mechanics and Foundation Engineering’, Vol. I- II. *Standard Book House, Delhi*
7. Swami Saran: ‘Analysis and Design of Substructures’*, Oxford and IBH publishing company, Delhi 1998*

SemesterVII		
Course Code	**Course Name**	**Credits**
CE-C ILOC-7011	**Institute Level Elective: Product Life cycle Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Module	Detailed Contents	Hrs
I	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	**10**
II	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	**09**
III	**Product Data Management (PDM):**	**05**

	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
IV	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	**05**
V	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	**05**
VI	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	**05**

Contribution to Outcomes:

Students will be able t

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7012	**Institute Level Elective: Reliability Engineering**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Module	Detailed Contents	Hrs
I	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye’s Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**08**
II	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**08**
III	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**05**
IV	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**08**
V	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics,	**05**

	Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
VI	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**05**

Outcomes

Students will be able to…

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Assessment:
Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7013	**Institute Level Elective: Management Information System**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Module	Detailed Contents	Hrs
I	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	**4**
II	**Data and Knowledge Management**: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	**7**
III	**Ethical issues and Privacy**: Information Security. Threat to IS, and Security Controls	**7**
IV	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	**7**
V	**Computer Networks Wired and Wireless technology**, Pervasive computing, Cloud computing model.	**6**
VI	**Information System within Organization**: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. **Acquiring Information Systems and Applications**: Various System development life cycle models.	**8**

Contribution to Outcomes

Students will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

SemesterVII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7014	**Institute Level Elective: Design of Experiments**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Detailed Contents	Hrs
I	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	**06**
II	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	**08**
III	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	**07**
IV	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design	**07**

	4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
V	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	**07**
VI	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	**04**

Contribution to Outcomes

Students will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rdedition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7015	**Institute Level Elective: Operation Research**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Module	Detailed Contents	Hrs
I	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	**14**
II	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	**05**

III	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**05**
IV	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	**05**
V	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**05**
VI	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	**05**

Outcomes:

Students will be able to

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7016	**Institute Level Elective: Cyber Security and Laws**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Module	Detailed Contents	Hrs
I	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	**4**
II	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	**9**
III	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	**6**
IV	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	**8**

V	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	**6**
VI	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	**6**

Outcomes

Students will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7017	**Institute Level Elective: Disaster Management and Mitigation Measures**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Module	**Detailed Contents**	**Hrs**
I	**Introduction** **1.1** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	**03**
II	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	**09**
III	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration:	**06**

	Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
IV	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	**06**
V	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	**09**
VI	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	**06**

Outcomes:

Students will be able to…

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. ‘Disaster Management’ by Harsh K.Gupta, Universities Press Publications.
2. ‘Disaster Management: An Appraisal of Institutional Mechanisms in India’ by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. ‘Introduction to International Disaster Management’ by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. ‘Disaster Management Handbook’ by Jack Pinkowski, CRC Press Taylor and Francis group.
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7018	**Institute Level Elective: Energy Audit and Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Module	Detailed Contents	Hrs
I	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	**04**
II	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	**08**
III	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.	**10**

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
IV	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	**10**
V	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	**04**
VI	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	**03**

Outcomes:

Students will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Semester-VIII

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 801	**Design and Drawing of Reinforced Concrete Structures**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Reinforced concrete construction are widely used for residential, commercial and industrial structures. IS code has specified the use of Limit State Method (LSM) design philosophy for design of structures. Pre-stressed Concrete structures are another class of structures used for bridge girders, long span slabs etc.Civil engineers must have knowledge of designing and detailing of RCC and PSC structures to make structures safe and serviceable during its life span.Also the knowledge about response of structures during an earthquake is prerequisite of design engineers. During previous semester students have studied design of basic elements by LSM. This course coves complete design of G+ 3 structures in addition to advanced topics of design of water tank and retaining wall. The course also contains PSC beam topics and introduces Earthquake Resistant Design of structures, drawing and detailing of structures.

Objectives

- To explain the LSM design procedure of G+ 3 structures by proper application of IS code clauses including loading calculation, analysis and design of individual elements.
- To acquaint the concepts in the design of staircase, water tank and retaining wall.
- To explain concept of Pre-stressed Concrete members.
- To introduce Earthquake Resistant Design method.
- To explain drawing and detailing of structures.
- To develop the concept of design using ready charts and curves for different elements of structure.

Detailed Syllabus		
Module	**Contents**	**Hrs**
I	**COMPREHENSIVE DESIGN OF BUILDING:** Complete design of residential/commercial/industrial G+ 3 structures. Load transfer mechanism, arrangement of beams, slabs, columns. Design of footing, beams, columns, staircase, lintels, chajja.	**12**
II	**DESIGN OF STAIRCASE:** Design of dog legged and open well staircase	**3**
III	**DESIGN OF RETAINING WALL:** Design of Cantilever and Counterfort retaining wall	**7**
IV	**DESIGN OF WATER TANK** Classification of Water Tank, Permissible Stresses, design of circular and rectangular water tanks resting on ground and underground. Codal provisions. Use of IS coefficient method and approximate method. Design of elevated water tank frame and shaft type of staging.	**11**
V	**EARTHQUAKE RESISTANT DESIGN OF STRUCTURES:** Earthquake and ground motion, response of structure, design forces calculation by seismic coefficient method. Ductile design and detailing as per IS:13920.	**12**
VI	**PRE-STRESSED CONCRETE:** Pre-stressed Concrete: Basic principles of pre-stressed concrete, materials used, systems of pre-stressing, losses in pre-stress, analysis of beam sections at transfer and service loads.	**7**

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

- Design independently RCC structure by applying IS code provisions.
- Design staircase, water tank and retaining wall.
- Explain principles of PSC and calculate losses.
- Draw and explain the structural detailing.
- Explain response of structure during an earthquake and calculate design forces.

Theory Examination:-

- Question paper will comprise of five questions. First question will carry 32 marks and remaining four will carry 16 marks each. The **first** question will be **compulsory.** From remaining four questions any **three** questions can be answered. Total **four** questions need be attempted.
- The **first** question will be based on design project from following. (any one out of given two is to be answered)
- Design of slab and continuous beam (max three span) or design of column from terrace to footing.
- Design of counter fort retaining wall
- Design of overhead water tank including design of staging
- The next four questions will be based on remaining modules of syllabus and the weightage of the marks shall be judiciously awarded in proportion to the importance of the module and number of hours allotted for the module. There can be an **internal** choice in various

sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

- All relevant IS codes will be allowed during examination.

Oral Examination:@

The oral examination accompanied by **sketching** will be based on entire syllabus and the term work and site visit report.

Term Work:

The term work shall consist of a neatly written Design Report including detailed drawings on the following topics:

- Design report of (G+3) building using relevant IS codes.
- Design report of counter fort retaining wall OR overhead water tank and staging.
- Report of one site visit to under construction building/PSC site.
- Assignments consisting of max five questions each on module III to VI.

Design report and at least four A-1 (Full imperial) size drawings sheets for above two projects shall be submitted as term work. All drawing work is to be done in pencil only. Design of building project will be done using design aids and anyone of available software.

Distribution of Term Work Marks: The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled design report; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Design report and drawing sheets : 15marks
- Assignments and site visit report: 05 marks
- Attendance : 05 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

Recommended Books:-

1. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Shah and Karve,* Structure Publications, Pune.
3. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand& bro.
4. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
5. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve,* Structure Publications, Pune.
6. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A,John Wiley.
7. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons.
8. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
9. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House,NewDelhi
10. Prestressed concrete, problems and solutions , Krishna Raju, CBS Publishers and distributors, New Delhi.
11. Prestressed concrete: N. Rajgopalan, Narosa Publishers.
12. Earthquake resistant design of structures: S. K. Duggal, Oxford University Press.
13. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
14. Relevant IS Codes: BIS Publications, New Delhi

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 802	**Construction Management**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This course is intended to teach students the management skills to be applied during all the stages of Civil Engineering Project. The professional construction engineering practice will be rendered meaningless if service is not offered with a scientific approach and managerial practices. This course deals with the techniques to be applied for scheduling projects, optimizing time-cost and other resources in construction, monitoring & ensuring quality and safety aspects in projects.

Objectives

- To understand the basic functions and construction management.
- To apply scheduling techniques such as CPM & PERT.
- To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.
- To understand allocating the resources and project monitoring
- To know about safety and quality aspect of construction works..

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	**Introduction to Construction Management** 1.1 Concept of Management, Principles of management, contribution by eminent personalities towards growth of management thoughts. 1.2 Significance of construction, management, objectives& functions of construction management 1.3 Resources required for construction.	**06**

II	**Construction Projects:** 2.1 Role of Construction industry in economic development of country 2.2 Unique features of construction industry. 2.3 Construction projects- Classification, Characteristics, Project life cycle etc. 2.4 Roles and responsibilities of various agencies associated with a Construction project. 2.5 Pre-requisites of commencing construction work such as sanctions, Approvals to be sought, and feasibility studies. 2.6 Site layout, organizing & mobilizing the site	**06**
III	**Construction project planning & Scheduling:** 3.1 Stages of planning in the view of owner/Department as well as contractor. 3.2 W.B.S, Bar Charts. 3.3 Network-Terminology, Network Rules, Fulkerson's rule, skip numbering, Precedence network etc. 3.4 C.P.M- Activity & event with their types, activity times, event times, Critical path, forward pass, backward pass, float & its types. 3.5 P.E.R.T- Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project etc.	**12**
IV	**Resources Management & Allocation :** 4.1 Material Management- Importance, objectives, functions of material management, Inventory control, A-B-C analysis, E.O.Q etc. 4.2 Human Resource Management- Manpower planning, recruitment, Selection training, performance evaluation of worker etc. 4.3 Resources Allocation Methods- Resource levelling resource smoothening.	**10**
V	**Project Monitoring & Cost Control :** 5.1 Supervision, record keeping, Periodic progress reports etc. 5.2 Updating- Purpose of frequency of updating method of updating a network etc. 5.3 Time cost optimization in construction projects compression & decompression of network etc. 5.4 Common causes of time over run & cost overrun & Corrective measures.	**08**
VI	**Construction Safety, Quality Control & Labour Legislation :** 6.1 Common causes of accidents on construction sites, costs of accident, precautionary measures to avoid accidents, 6.2 Occupational health hazards in construction industry. 6.3 Safety & Health Campaign. 6.4 O.S.H.A 6.5 Concept of Quality, quality control check list in quality control etc. 6.6 Role of inspection in quality control, 6.7 Quality manual, Quality assurance statistical quality control 6.8 ISO14000 6.9 Need for legislation & Importance of labour laws. 6.10 Acts applicable to Indian construction labours such as Payment of wages act, Minimum wages act, Workmen's compensation act, Factories act etc.	**10**

Contribution to Outcomes

On completion of the course, the learners will be able to:-

- Understand & apply the knowledge of management functions like planning, scheduling, executing & controlling the construction projects.
- Prepare feasible project schedule by using various scheduling techniques.
- Gain knowledge of managing various resources &recommend best method of allocating the resources to the project.
- develop optimum relationship between time & cost for construction project
- Implement quality & safety measures on construction sites during execution of civil engineering projects.
- Understand the importance of labour legislation

Term Work: At least 10 assignments covering the entire syllabus.

Distribution of Term Work Marks: The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 marks
- Attendance : 05 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

Theory Examination:

- The question paper will comprise of six questions, each carrying 20 marks.
- The first question will be compulsory & out of remaining questions students have to attempt any three questions.
- Total four questions need to be attempted.

Oral Examination: The oral examination shall be based on the entire syllabus & the Term-work prepared by the students including assignments..

Recommended books:

1) Construction Engineering and Management: S.Seetharaman.
2) Construction Planning & Management – Dr.U.K.Shrivastava.
3) Professional Construction Management: Barrie D.S. & Paulson B C, McGraw Hill
4) Construction Project Management: Chitkara K K Tata McGraw Hill
5) Handbook of Construction Management: P K Joy, Macmillan, India
6) Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley
7) Construction Hazard and Safety Handbook: King &Hudson, Butterworths

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8031	**Department Level Elective:** **Advanced Design of Steel Structures**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

There are various types of the Civil Engineering structures which are subjected to various types of loading and their combination. Most of the industrial structures for which the higher strength is a prime concern, are made up of steel .These special structure are design by working stress method and limit state method. The design approaches of different components given in the syllabus are based on limit state method and working state method.

Objectives

- To understand the analysis and design concept of round tubular structures
- To understand the design concept of different type of steel water tank
- To understand the design concept of lattice tower and steel chimney
- To understand the design concept of gantry girder
- To develop Civil Engineering graduates having clear understanding of concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.
- Use various relevant IS codes for designing such special steel structures

Detailed Syllabus		
Module	**Sub – Modules / Contents**	**Hrs**
I	**1.1 Introduction to Steel Structure** Introduction to types of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM), Limit state method and design of simple bolted connection.	**03**
	1.2 Moment Resistant Beam End Connections : Design of moment resistant bolted and welded beam end connections by limit state method	**05**
II	**2.1 Round Tubular Structural Members :** Properties of steel tubes, design of tension member and compression member, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports.	**06**
III	**3.1 Elevated Steel Tanks and Stacks :**	**14**

	Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation, design of rectangular steel tanks including design of staging, columns and foundation. .(consider the effect of wind and earthquake)	
IV	**4.1. Gantry Girder :** Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	**07**
V	**5.1 Lattice Tower :** Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower, design of lattice tower including welded or bolted connections for members by limit state method.(consider the effect of wind and earthquake)	**09**
VI	**6.1 Steel Chimney :** Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation. .(consider the effect of wind and earthquake)	**08**

Contribution to Outcomes

On completion of this course, the students will be able

1. To perform the analysis and design of special steel structures
2. The will be able to analysis and design the gantry girder by limit state method.
3. They will be able to analysis and design steel chimney, lattice tower, tubular truss and water tank
4. Students should able to independently design steel structures using relevant IS codes.

Theory Examination:-

1. Question paper will comprise of six question; each carrying 20 marks.
2. The first question will be compulsory and will have short question having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work consisting of the assignments and projects.

Term Work:

The Term work shall consists of a design report and detailed drawings on three projects as indicated below:

1) Roofing system including details of supports using tubular section
2) Design of elevated circular tank with conical bottom or rectangular steel tank.
3) Design of lattice tower or steel chimney.

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets. Each student has to appear for at least two written test during term .The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work.

The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments and projects.

Recommended Books:

1. Design of Steel Structures : N Subramanian,Oxford- University Press
2. Design of Steel Structures: Punamia, A. K. Jain &Arun Kumar Jain .Laxmi Publication
3. Design of Steel Structures: Dayaratnam, Wheeler Publication, New Delhi.
4. Design of steel structures: Krishnamachar B.S, &AjithaSinha D.
5. Design of Steel Structures: Mac. Ginely T.
6. Design of Steel Structures: Kazimi S. M. & Jindal R. S., Prentice Hall of India.
7. Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.
8. Design of Steel Structures: Arya and Ajmani, New chand& Bros.
9. Relevant IS codes, BIS Publication, New Delhi
10. Steel structures, Controlling behavior through design: R. Englekirk, Wiley
11. LRFD Steel Design : William T. Segui, PWS Publishing
12. Design of Steel Structures: Edwin H. Gaylord, Charles N. Gaylord and James. Stallmeyer, McGraw-Hill

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8032	**Department Level Elective:** **Industrial Waste Treatment**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Industrial waste waters are generally much more polluted than the domestic or even commercial wastewaters. Such industrial wastewaters cannot always be treated easily by the normal methods of treating domestic wastewaters, and certain specially designed methods. In order to achieve this aim, it is generally always necessary, and advantageous to isolate and remove the troubling pollutants from the wastewaters, before subjecting them to usual treatment processes. Thus Wastewater treatment is closely related to the standards and/or expectations set for the effluent quality. Wastewater treatment processes are designed to achieve improvements in the quality of the wastewater.

Objectives

- To provide knowledge of different types and characteristics of industrial wastes. Also to make the students conversant with effluent and stream standards.
- To study the problems faced by many industrial plants with new effluent limits to be met with their existing treatment plant.
- To understand in-depth yet practical review of wastewater treatment technologies and how to optimize their operation.
- To develop rational approaches towards sustainable waste water management via sludge recovery and treatments.
- To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by various industrial activities prior to its release into the environment or its re-use.
- To study the sources of contaminants, legislative framework for their remediation as well as the technical aspects of the unit operations involved. To Utilize EIA documents for policy development, project planning or for legal or political action planning.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	General:Liquid wastes from industries – their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, stream standards and effluent standards.	**04**
II	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	**04**
III	Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelp's equation and BOD equations, Deoxygenating and reaeration , Oxygen sag and numerical based on this.	**06**
IV	General treatment of industrial wastes:Neutralization, Equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges,unit operation– floatation, Vacuum filtration, Centrifugation, Filter press and membrane filters, Advanced treatment.	**12**
V	Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed , Volume and effects of raw and treated effluent on streams, Sewers, Characteristics of effluents and land Treatment methods, reuse-recovery 1) Sugar-sugarcane 2) Distilleries 3) Pulp & paper: Sulphate process 4) Textiles: Cotton 5) Dairy 6) Tanneries 7)Electroplating	**16**
VI	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit. Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation & Maintenance Problems and Economical aspects.	**10**

Contribution to outcomes

On completion of this course, the students will have an ability to understand the industrial waste sources, effects and its treatment. The students will understand the various methods of disposal of industrial waste. They will have an understanding of the nature and characteristic of industrial waste and regulatory requirements regarding industrial waste treatment and further, they will have an ability to plan industrial waste minimization.

Students should able to

- Understand the characteristics of industrial wastewater.
- Identify sampling method and analyze industrial waste.
- Design facilities for the processing and reclamation of industrial waste water.
- Explain on-site treatment methods and solve Analyze and design wastewater treatment systems. (floatation, vacuum filtration, centrifugation, filter press and membrane filters)
- Detailed on-site manufacturing processes and treatments of industrial waste water.
- Analyze proposed development project plans for possible environmental effects and to improve treated effluent quality to confirm standard prescribed by regulatory agencies.

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments and Tutorial including the site visit report.

Term Work:

Mini Project- Student should perform activities related to solid waste management at institute level forming groups 4 to 5 students, Report of the activity should be part

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report comprising design criteria and flow sheet of the proposed treatment scheme including laboratory analysis for any one industrial waste. Demonstration of available software for design of effluent treatment plant is to be considered.
The following weightage of marks shall be given for different components of the term work.

- Report (on any industry/site visit): 05 Marks
- Seminar/Mini Project : 05Marks
- Attendance : 05 Marks
- Assignments and Tutorials :10 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Waste Water Treatment: Rao & Datta, Oxford & IBH Publishing Co.
2. Environmental Pollution and control in chemical process industries: S.C.Bhatia, Khanna Publication.
3. Industrial Water Pollution Control: W W Eckenfelder Jr, Mc Graw Hill.
4. Industrial Water Pollution Management: E F Gurnham, John Wiley.
5. Biological Waste Treatment: Eckenfelder & Connor Pergamon Press.
6. Theories and Practices of Industrial Waste Treatment: Addisoon Wesley.
7. Pollution Control in Process Industries: S P Mahajan , Tata mcgraw Hill.
8. Industrial Waste: W Rudolfs ,(Ed), L E C Publishers Inc.
9. The Treatment of Industrial Wastes: E D BesselievreMcgraw Hill.

10. Industrial Waste Disposal: R D Ross , (Ed), Reinhld Bok Croporation.
11. Wastewater Engineering, Treatment and Reuse : Metcalf and Eddy,Tatamcgraw Hill
12. Industrial Wastewater Management Handbook, Hardam S. Azad.
13. Industrial Waste Treatment, Frank Woodwoard.
14. Environmental Impact Assessment :Larry W. Canter, Mcgraw Hill Book Company.
15. Environmental Impact Analysis Handbook :G.J. Rao and C.D. Weeten ,Mcgraw Hill
16. Environmental Management, Vijay Kulkarni and T. V. Ramchandra, Capital Publishing
17. Environmental Audit, MhaskarA.K.,Enviro Media Publications.

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8033	**Department Level Elective: Pavement Design and Construction**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

The pavements are classified according to mode of transportation (highway and airways) and structural behaviour (flexible and rigid). The design of any pavement warrants the proper analysis thereof. The course deals with the various methods of the analyses and design of pavements. The evaluation of the pavements on routine basis and subsequent maintenance is essential to avoid the distresses in pavements. The course also covers the various distresses likely to take place in the pavements and various methods of evaluating the existing pavements. The distressed pavement needs either strengthening or rehabilitation depending upon the distresses the pavement has undergone. For the proper working and maintenance of the pavement, the concept of pavement management system has emerged. The course also covers these aspects. It also gives major thrust on the low volume roads and construction of concrete roads.

Objectives

- To study the different types of pavements(highway and airfield) depending upon the mode of transportation, use and structural behaviour.
- To understand the concept of consideration of wheel loads, axle loads, wheel-axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
- To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations.
- To study the various methods of analysis and design of the pavements and its subsequent applications to the various types of pavements.
- To study the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
- To study the construction of the concrete roads and low volume roads.
- To study the quality control and quality assurance in the road construction and introduce pavement management system.

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I.	Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highways and airports, development of design method for highway and airport pavements.	**12**
	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL Stresses in Rigid pavement: load and temperature stresses, combined stresses.	
II.	Flexible Pavement Design Airport pavement: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. Highway Pavement: Empirical methods using no soil strength criteria, empirical method based no soil strength criteria: CBR method as specified by IRC-37 1970,1984,2001,2012,2018 Road note 29 methods, AASHTO method, Asphalt institute method. Fatigue and rutting as a failure criterion.	**16**
	Rigid Pavement Design: Airport pavements: PCA methods, corps of Engineer's method, FAA method. Joints and reinforcement requirement. Highway pavement: Current British procedure, IRC-58-2012,2015. method.	
III.	Evaluation and strengthening: flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman beam deflections, design of overlays(IRC-81-1997), skid resistance and measurement.	**12**
	Concrete road construction: Mix design, concrete strength, size of aggregates, gradation, and workability, preparation of base form work, placing of reinforcement, compaction, and finishing, curing, joints.	
IV.	Low Cost Roads (Rural Areas) (IRC-SP-20-2002) Classification of low cost roads, construction of low cost roads, stabilization of subgrade, base and its advantages, construction of granular base courses, macadam surface, macadam bases, low cost materials and methods used for highway construction, suitability of different types of roads under different situation. Soils.	**05**
V	Quality control (QC) and Quality assurance (QA) during construction of various pavements, importance, process control and end product control, statistical methods in quality control, control charts, frequency of testing etc. (IRC-SP-11-1997) (MORTH SECTION 900).	**05**
VI	Introduction to pavement management systems.	**02**

Course Outcome

On successful completion of the course, the students shall be able to:

- Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
- Understand the applications of the analysis in the design of pavements using different methods of pavement design.
- Know the different types of distresses occurring in the existing pavements and carry out the structural and functional evaluation of the pavements.
- Apply the knowledge of evaluation in pre-empting the failure and to arrive upon the methodology of the rehabilitation of pavements.
- Understand the various aspects of the construction of concrete roads and low volume roads.
- Understand the pavement management system and quality control and assurance criteria and subsequently, its application in the highway construction.

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:-

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality of the term work. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Principles and Practice of Highway Engineering: *L.R.Kadiyali,* Khanna publications.
2. Highway Engineering: *Khanna S.K. and Justo* C.E.G. Nem Chand (Revised 10th Edition, 2014)
3. Pavement design
4. Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3rd Revised Edition, 2013) 4.Pavement Analysis and Design: *Yang H. Huang*, Prentice Hall, New Jersey, 1993
5. Pavement Design: *Yoder* and*Witzech*, McGraw-Hill, 1982.
6. The Design and Performance of Road Pavements: *Croney, David et al*, McGraw Hill.

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8034	**Department Level Elective:** **Bridge Engineering and Design**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

In the age of increase in traffic load and rapid transportation, bridges are a very important part of a nation's transportation infrastructure associated with the economic growth. They allow for roads and railways to cross over otherwise impassable obstacles such as rivers, valleys or other roads etc. Bridges are being built mainly with reinforced concrete, pre-stressed concrete or steel depending on various factors such as environment& site conditions, nature of loads and span etc. The civil engineering profession is much concerned with proper planning, design and construction, as well as maintenance, repairs and rehabilitation of bridges which are of utmost importance. In this subject, students will be well acquainted with the types of bridges and their selection based on the specific needs. They will learn analysis and design of superstructure of Reinforced Concrete Culvert and Pre-stressed Concrete bridges for IRC loads along with basics of substructure (foundation, Pier, abutments) using relevant IRC. They will also understand the analysis and design of a lattice girder bridge in steel for railway loading using relevant bridge rules and IRS.

Objectives

- To bring the students to such a level that they being civil engineers will be able to take the appropriate decision in respect of choice of site, type of bridge, components of bridge, superstructure, sub structure, foundation, type of bearing and launching method of girder and construction methods.
- To make the candidate to understand the analysis and design of reinforced concrete culvert/Pre-stressed Concrete bridges using relevant IRCs.
- To make the candidate to understand the analysis and design of lattice girder steel bridge for railway loading using relevant IRS code.

Detailed Syllabus		
Module	**Sub module/Contents**	**Hrs**
I.	**Introduction:** Types of Bridges, Selection of suitable site and type of bridge, Components of a bridge, aesthetics, economic span	**06**
II.	**Design Loads and their Distribution:** **IRC loads:** IRC-Class AA tracked and wheeled, 70R tracked and wheeled, Class-A, Class-B, distribution of loads on RC culverts, Pre-stressed Concrete deck slab and girdered bridge, **IRS loads**: Railway loading and distribution on lattice girder bridge	**10**
III.	**Design of Superstructure:** Design of pre-stressed concrete deck slab bridge, I-girder bridge and box girder bridge for roadway, Design of RC Culvert, Design of balanced cantilever RC bridge for roadway, Design of steel lattice girder bridge for railway	**20**
IV.	**Substructure:** Different types of foundations, their choice and methods of construction, well foundation, pile foundation, piers and abutments, wing walls	**06**
V	**Bearing:** Various types of bearings and their suitability	**05**
VI	**Construction Methods:** Various methods of erection of bridge girders, cantilever method of construction of bridge	**05**

Contribution to outcome

On successful completion of the course, the student shall be able to:

- Select the suitable type of bridge according to the site condition.
- Understand IRC loads, distribution of these loads on deck slab and among longitudinal beams/girders of a bridge.
- Design of culvert, balanced cantilever reinforced concrete bridge, prestressed concrete deck slab bridge, I-girdered and box girdered bridge, lattice girder railway bridge.
- Understand different types of foundations, piers and abutments, their methods of construction.
- Understand various types of bearings and their suitability, erection of bridge superstructure.

Theory Examination: -

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to importance of sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Site Visit/ Field Visit:
The students shall visit the site where the construction of bridge structure using pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

Oral Examination:
The oral Examination shall be based upon the entire syllabus, term work and site/field visit.

Term work:
The termwork shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus. There shall be minimum four problems for design of roadway bridges and one railway bridge.
Presentation on any emerging trend in bridges, its design, methods of erection and construction, types of foundations and bearings etc relevant to syllabus.

Distribution of Term Work Marks:
The marks of the term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and the acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: **10 Marks**
- Presentation: **05 Marks**
- A Bridge site visit report **or** A project on Design of superstructure of a bridge using software: **05 Marks**
- Attendance: **05 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

References

A-Recommended Books:

1. Design of Bridges: *Raju N. K.*, Oxford and IBH fifth Edition.
2. Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill.
3. Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill.
4. Essentials of Bridge Engineering: *Victor D.J*, Oxford and IBH.
5. Design of Bridge Superstructures: *T.R. Jagdeesh*and*M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi.
6. Bridge Engineering Handbook: *Chen W. F. and Duan L.*, CRC Press, 2000.
7. Bridge Bearings and Expansion Joints: *David Lee*, E & FN Spon.

B-IRC Codes:

IRC: SP13- 2004, IRC: 5- 2015, IRC: 6- 2016, IRC: 18-2000, IRC: 21-2000, IRC: 24-2001, IRC: 27-2009, IRC: 45, IRC: 78-2014, IRC: 83 (i)-1999, IRC: 83 (ii)-1987, IRC: 83 (iii)-2002, IRC:112- 2011

C-IRS Codes:

IRS- 2003, Bridge rules (Railway board): Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges- 2008.

Indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic (steel bridge code) adopted- 2003

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8035	**Department Level Elective: Appraisal & Implementation of Infrastructure Projects**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This course is intended to make students aware of the appraisal criteria for any Civil engineering project. This course will make students understand the importance of feasibility studies and acquaint them with the process of preparing a project report, both of which play a significant role in deciding the viability of a project. The professional construction engineering practice will be rendered meaningless if student do not grasp the knowledge of financial analysis. This course shall be helpful to students in studying all the economic aspects of Infrastructure projects.

Objectives

- To know the procedure of feasibility studies for any infrastructure project.
- To learn the procedure of appraisals required for deciding the worthiness of any project.
- To learn the procedure of forecasting demand and know its importance.
- To know the components and importance of technical appraisal.
- To make students acquainted with important decision making tools like Break even analysis, SWOT analysis and other ways to carry out economic analysis of a project.
- To get acquainted with different methods of implementing a project.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Hrs**
I.	**Construction Projects and Report Preparation**		**06**
	1.1	Classification of construction projects. Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis. Preparation of Project report.	
II.	**Project Appraisal**		**08**
	2.1	Importance and phases in a project development cycle for major infrastructure projects.	
	2.2	Importance of Appraisal, its need and steps involved in it.	
III.	**Market Appraisal**		**10**
	3.1	Importance and methods of carrying out demand analysis. Sources to gather project related information and ways to carry out market survey.	
	3.2	Methods to forecast demands. Uncertainities involved in demand forecasting.	
IV.	**Technical and Managerial Appraisal**		**08**
	4.1	Method to study the technical appraisal/viability of a project in terms of its location, type of land and intended use of building, technology requirements of the project, Size and complexity of tools and plants, raw materials to be used and their impact on the vicinity, energy requirements, water supply and disposal of effluents if any.	
	4.2	Study of managerial requirements of a project, Desirable organisational structure and hierarchy to manage as well as implement the project, Method of assessment of entrepreneurs.	
V.	**Financial analysis and Economic Appraisal**		**10**
	5.1	Various costs related to a project, Methods to determine the profitability of a project, Break even analysis.	
	5.2	Economic appraisal: Urgency, Payback period, Avg. Rate of return, Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VI.	**Project Financing and Implementation**		**10**
	6.1	Types and Sources of finance in local, National and International context. Issues related to project financing.	
	6.2	Agencies involved in the implementation of a project. Methods of implementation like Built, operate and Transfer and its other variants like B.O.O, B.O.O.T, B.L.T, etc.	

Contribution to Outcomes

On successful completion of the course, the learners will be able to:

- **Classify** the projects and **describe** the phases involved in project formulation.
- **Prepare** detailed project report on the basis of various feasibility studies and SWOT analysis.
- **Devise** a project's development cycle and get acquainted with the different appraisals in the process of deciding the worthiness of a project.
- **Exhibit** and **apply** the managerial skills and knowledge of financial aspects required during the implementation of projects.
- **Identify** various sources for project finance.
- **Know** the various agencies involved in project implementation as well as **select** the method of project implementation which is best suited for a particular project.

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work shall consist of the following:

- Minimum **Six assignments** covering the entire syllabus**.**
- **Report** on studying the SWOT Analysis of any one major infrastructure project.
- **Case study – Powerpoint presentation** covering the various appraisals of any one major infrastructure project.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and powerpoint presentation. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

Assignments:20 Marks.

Attendance: 05 Marks. Further, while giving weightage of marks on the attendance, guideline to be resorted to is: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Mark

Recommended Books:

1) Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra (Tata McGraw Hill).
2) Infrastructure Development & Financing in India - N. Mani (New Century Publications).
3) Infrastructure & economic development - Anu Kapil (Deep&Deep Publications).
4) Construction Management: Planning and finance - Cormican D.(Construction press, London).
5) Engineering Economics – Kumar (Wiley, India).
6) Real Estate, Finance and investment - Bruggeman.Fishr (McGraw Hill).
7) The cost management toolbox; A Managers guide to controlling costs and boosting profits. - Oliver, Lianabel (Tata McGraw Hill).

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8036	**Department Level Elective: Soil Dynamics**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

In basic geotechnical engineering course generally various static loads are considered in the theories and analysis of soil. But practically many geotechnical applications require the knowledge of the behaviour and properties/response of soil as a material which is subjected to various types of dynamic or cyclic time-dependent loadings. Some of the structures which are subjected to dynamic loadings are machine foundations, shallow and deep foundations, retaining structures, slopes, sub grade soil below railway, pavement, runway etc. This course provides the fundamental theoretical and computational aspects of dynamics for some important geotechnical problems and structures.

Objectives

- To study fundamental concepts of vibrations, degrees of freedom and damping systems.
- To study phenomena like liquefaction and their effects.
- To study principals of machine foundation design and dynamic earth pressure theories on retaining wall.
- To learn test methods of evaluating dynamic properties of soil.
- To know the basic earth pressure on retaining walls

Detailed Syllabus		
Module	**Sub- Modules/Contents**	**Hrs**
I.	Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics. Vibration of elementary system, degree of freedom, analysis of system with one degree of freedom, spring-mass system, harmonic vibration, uniform circular motion natural frequency, free and forced vibrations with and without damping, type of damping	**10**
II.	Wave propagation in elastic rods, in an elastic infinite medium and in Semi-elastic half space, wave generated by surface footing.	**05**

III.	Liquefaction of soils, criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefaction potentials, Liquefaction of clay.	**10**
IV.	Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration. Practical design considerations and codal provisions.	**06**
V.	Vibration isolation and screening methods, improvement of distressed machine foundation.	**07**
VI.	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils. Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure, point of application of the resultant, simple examples.	**14**

Course Outcome

On successful completion of the course, the students are expected to:

- Acquire the knowledge of concepts, principles and applications of soil under dynamic loading.
- Develop an ability to design with reference to code provisions and solve the practical soil problems subjected to vibrations.
- Provide an impetus to new developments in related dynamic topics.
- Carry out field tests on soil to know the dynamic properties of soil.
- Calculate the dynamic earth pressure on retaining walls.

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** questions.

Total **four** questions need to be attempted.

Laboratory Test

It is recommended to conduct block foundation tests.

Oral Examination:-

The oral examination will be based on the entire syllabus.

Term Work:

Each student shall prepare a project report covering the selection of design parameters, design analysis including drawing on any aspect of soil dynamics included in the syllabus. The project report referred above along with the assignments will form a part of the term work. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub- modules and contents thereof, further. The report on the block vibration tests, if conducted, shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for various components of the term work depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments, proper compilation of the project report and that of experiments/ practical, if conducted;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20Marks
- Attendance : 05Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended books:

1. Soil Dynamics: *Shamsher Prakash,* McGraw-Hill book company
2. Principles of Soil Dynamics: *Braja, M. Das,* PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: *Barkan, D. D.,* McGraw- Hill Book company
4. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall lnc.
5. E. E. Richart et al. "Vibrations of Soils and Foundations", Prentice Hall Inc.
6. Relevant IS codes

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8037	**Department Level Elective:** **Applied Hydrology & Flood Control**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This subject deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It focuses on types and forms of precipitations. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows. It further describes the various techniques of estimating streamline flows. It also describes the importance of floods, flood routing and ground water hydrology.

Objectives

- To understand the various processes involved in the hydrological cycle.
- To measure rainfall, computation of average rainfall, various water losses etc.
- To know the various stream flow measurement and its importance.
- To study the hydrograph and unit hydrographs, applications of unit hydrograph concept.
- To study various flood control methods, estimate design flood, and flood routing
- To study the concepts of ground water movement, steady and unsteady flow towards fully penetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I	**Introduction:** Hydrological cycle, scope of hydrology, water budget equation, data sources. **Precipitation:** Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration -Frequency relationship, Probable Maximum Precipitation.	**10**
II	**Abstractions from Precipitation:** Evaporation and transpiration, evapo-transpiration, interception, epression storage, infiltration and infiltration indices, determination of water losses. **Stream Flow Measurement:** Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	**10**
III.	**Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	**8**
IV.	**Hydrograph Analysis:** Characteristics, base *flow* separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	**8**
V.	**Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor. Flood routing: Hydrologic and hydraulic routings.	**8**
VI.	**Ground Water Hydrology:** Yield , transmissibility, Darcy's law, DuPont's theory of unconfined flow, steady flow towards fully penetrating wells(confined and unconfined).Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	**8**

Contribution to Outcomes

On successful completion of the course, the students are expected to:

- Explain hydrologic cycle and various methods of Measurement of rainfall.
- Calculate optimum number of rain gauge stations for average rainfall and missing rainfall over catchment
- Describe various methods of measurement of stream flow and to calculate abstraction losses over the catchment
- Develop rainfall runoff relationship and calculating runoff over catchment
- Perform hydrologic and hydraulic routing
- Derive the equations for the discharge of well for confined and unconfined aquifer

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term Work:

The term work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and / or questions on each sub-modules and contents thereof further.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

Assignments : 20 Marks
Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

- Engineering Hydrology: *K. Subramanya*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Irrigation Engineering and Hydraulic Structures: *S. K. Ukarande*, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
- Hydrology: *H. M. Raghunath*, New Age International Publishers, New Delhi
- Irrigation and Water Power Engineering: Dr. *B.C. Punmia* and Dr. *Pande, B.B.Lal*, Laxmi Publications Pvt. Ltd. New Delhi.
- Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi
- Irrigation Water Resources and Water Power Engineering: Dr. *P.N. Modi*, Standard Book House. Delhi.
- Elementary Hydrology: *V. P. Singh*, Prentice Hall
- Engineering Hydrology: Principles and practice*: V. M. Ponce*, Prentice Hall

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C ILOC8021	**Institute Level Elective: Project Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Module	Detailed Contents	Hrs
I	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	**5**
II	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	**6**
III	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	**8**

IV	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	**6**
V	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	**8**
VI	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	**6**

Outcomes

Students will be able to :

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 questions
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8022	**Institute Level Elective: Finance Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Module	Detailed Contents	Hrs
I	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	**06**
II	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	**06**
III	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	**09**

	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
IV	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10**
V	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**05**
VI	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	**03**

Outcomes

Students will be able to…

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8023	**Institute level Elective : Entrepreneurship Development and Management**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Module	**Detailed Contents**	**Hrs**
I	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	**04**
II	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	**09**
III	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	**05**

IV	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	**08**
V	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	**08**
VI	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	**05**

Outcomes:

Students will be able to…

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad

8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8024	**Institute level Elective : Human Resource Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Module	Detailed Contents	Hrs
I	**Introduction to HR** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
II	**Organizational Behavior (OB)** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);	7

	Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	
III	**Organizational Structure &Design** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**6**
IV	**Human resource Planning** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	**5**
V	**Emerging Trends in HR** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	**6**
VI	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labour Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**10**

Contribution to Outcomes:

Students will be able to:

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today’s emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.

- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8025	**Intitute level Elective : Professional Ethics and CSR**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	**04**
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	**08**
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm’s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	**06**
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	**05**
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)	**08**
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry	**08**

	of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	

Contribution to outcomes

Students will be able to…

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

SemesterVIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8026	**Institute level Elective : Research Methodology**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Module	**Detailed Contents**	**Hrs**
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature	**08**

	d. Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Outcomes

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

SemesterVIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8027	**Institute level Elective : IPR & Patenting**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	**05**
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	**07**
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	**05**
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while	**07**

	patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	**08**
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	**07**

Outcomes:

Students will be able to…

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian,2012,Intellectual Property Rights, 1st Edition,Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8028	**Institute Level Elective : Digital Business Management**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Module	Detailed content	Hrs
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	**09**
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	**06**
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	**06**

4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	**06**
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	**04**
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	**08**

Outcomes:

Students will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. A textbook on E-commerce**,** Er. Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8028	**Institute level Elective : Environmental Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Module	Detailed Contents	Hrs
I	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	**10**
II	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	**06**
III	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	**05**
IV	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	**10**
V	Total Quality Environmental Management, ISO-14000, EMS certification.	**05**
VI	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	**03**

Contribution to Outcomes

Students will be able to…

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

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AC. 11/5/2017

Item No. 4.177

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering (Second Year – Sem. III & IV)

Revised course (REV – 2016)

With Effect From Academic Year 2017 – 18

Under the

FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC. 11/5/2017

Item No. 4.177

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering (Second Year – Sem. III & IV)

Revised course (REV – 2016)

With Effect From Academic Year 2017 – 18

Under the

FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

Preface

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, semester based credit grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for First Year of Engineering from the academic year 2016 – 2017. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2017 – 2018, for Third Year and Final Year Engineering in the academic years 2018 – 2019, 2019 – 2020, respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education reflects the fact that in achieving recognition, the institution or program of study is committed open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I am happy to state here that, Program Educational Objectives were finalized in a meeting where syllabus committee members were also present. The Program Educational Objectives finalized for undergraduate program in civil Engineering are as follows:

1. To prepare Learner's with a sound foundation in the mathematical, scientific engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To prepare Learner's for successful career in Indian Multinational Organisations to excel in Postgraduate studies
4. To encourage motivate Learner's for self-learning
5. To inculcate professional ethical attitude, good leadership qualities commitment to social responsibilities in the Learner's

In addition to above each institute is free to add few (2 to 3) more Program Educational Objectives of their own. In addition to Program Educational Objectives, course objectives expected course outcomes from learner's point of view are also included in the curriculum for each course of undergraduate program to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. S. K. Ukarande
Chairman, Board of studies in Civil Engineering
University of Mumbai, Mumbai

University of Mumbai
Scheme of Instructions and Examination
Second Year Engineering (Civil Engineering)
(With effect from 2017- 2018)
(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					**TW**	**Oral & Practical**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration**			
		Test1	**Test2**	**Avg**					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai
Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					**TW**	**Oral & Practical**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (in Hrs)**			
		Test1	**Test2**	**Avg.**					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (In Hrs.)				
		Test 1	Test 2	Avg						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course ‘Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course ‘Business and Communication Ethics (CE-C 507)’ will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying	CE-DLO6061: Advanced Construction Equipment
CE-DLO5062: Advanced Concrete Technology	CE-DLO6062: Traffic Engineering and Management
CE-DLO5063: Building Services and Repairs	CE-DLO6063: Ground Improvement Techniques
CE-DLO5064: Advanced Structural Mechanics	CE-DLO6064: Advanced Structural Analysis

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	--	2	4		2	6
CE-C703	Water Resource Engineering -II	3	--	2	3	--	2	5
CE-DLO704X	Department Level Optional Course-III	3	--	2	3	--	2	5
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**8**	**6**	**17**	**4**	**6**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 705), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	2	--	4	1	-	5
CE-C802	Construction Management	4	2	--	4	1	-	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	--	3	--	--	3
CE-P804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**18**	**-**	**15**	**9**	**-**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	--	--	--	100
CE-P804	Project – Part II	--	--	--			50	--	50#	100
Total		**80**	**80**	**80**	**320**		**125**		**125**	**650**

The oral examination for the Project- Part II (CE-P 804) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.
(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.
(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Applied Hydrology and Flood Control

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester III

	Semester III	
Subject Code	**Subject Name**	**Credits**
CE-C 301	Applied Mathematics–III	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
- To study the basic principles of Laplace Transform, Fourier Series, Complex variables

Details Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Laplace Transform**		**12**
	1.1	Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$	

	1.2	Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform of Periodic functions	
	1.3	Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem (without proof).	
	1.4	Applications to solve initial and boundary value problems involving ordinary Differential equations with one dependent variable.	
II.	**2. Complex variables**		**08**
	2.1	Functions of complex variable, Analytic function, necessary and sufficient conditions for to be analytic (without proof), Cauchy-Riemann equations in polar coordinates.	
	2.2	Milne-Thomson method to determine analytic function when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories.	
	2.3	Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation.	
III.	**3. Complex Integration**		**08**
	3.1	Line integral of a function of a complex variable, Cauchy's theorem for analytic functions (without proof) Cauchy's integral formula (without proof) Singularities and poles:	
	3.2	Taylor's and Laurent's series development (without proof)	
	3.3	Residue at isolated singularity and its evaluation.	
	3.4	Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$, & $\int_{-\infty}^{\infty} f(x)\, dx$	
IV.	**4. Fourier Series**		**10**
	4.1	Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π & $2l$.	
	4.2	Dirichlet's theorem (only statement), even and odd functions, Half range sine and cosine series, Parsvel's identities (without proof)	

	4.3	Complex form of Fourier series.	
V.	**5. Partial Differential Equations**		**09**
	5.1	Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method).	
	5.2	Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series.	
	5.3	Heat equation, steady-state configuration for heat flow.	
	5.4	Two and Three dimensional Laplace equations.	
VI.	**6. Correlation and Curve Fitting.**		**05**
	6.1	Correlation-Karl Pearson's coefficient of correlation- problems. Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems	
	6.2	Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b, y = ax^2 + bx + c \text{ and } y = ae^{bx}$.	
		Total	**52**

Contribution to Outcomes

After completion of the course, students will be able to..

- Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations.
- Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations.
- Solve initial and boundary value problems involving ordinary differential equations.
- Identify the analytic function, harmonic function, orthogonal trajectories.
- Apply bilinear transformations and conformal mappings.
- Identify the applicability of theorems and evaluate the contour integrals.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus and may before this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to complete at least 8 class tutorials on entire syllabus.

Recommended Books:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 302	Surveying–I	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Surveying is a core subject for civil engineers. It is the first step towards all civil engineering projects. A good surveyor is an asset to the company, organization or establishment. All the civil engineering projects such as buildings, transportation systems including roads, bridges, railways, airports along with dams and water/ sewage treatment plants start with surveying as the basic operations. Hence, the knowledge of surveying is very essential to all the civil engineering professionals. In this subject, the students get acquainted with the basic methods and instruments that are used in surveying and it helps them to produce plans and sections. It is also useful in setting out civil engineering structures on construction sites.

Objectives

- To understand appropriate methods of surveying based on accuracy and precision required availability of resources, economics and duration of project.
- To study techniques for measurement of distance, setting offsets, calculate area and volume using surveying instruments
- To study the functions of various instruments, their least counts, possible errors, advantages and limitations.
- To study various techniques for solving Surveying related problems.
- To study the superiority and leverage of using modern methods in surveying over conventional ones.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Introduction**		08
	1.1	Definition, principles, objectives, classification, technical terms, uses and necessity of surveying. Units of measurement, surveying measurement and errors, type of errors and their corrections (including numericals), corrections for wrong scales, accuracy and precision, stages of survey operations	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Types, Instruments required, methods, obstacles (including numericals), sources of errors, conventional signs and symbols.	
	1.3	Electronic Distance Measurement: Working Principles, types, applications in surveying	
II.	**Measurement of Directions and Angles**		10
	2.1	Basic definitions, meridians, bearings, magnetic and true bearings, compasses, prismatic and surveyor's, temporary adjustments, declination, dip, local attraction	
	2.2	Types of traverse, procedures, control establishments, Conversion of WCB into RB and vice-versa, Traverse Survey and Computations of interior angles of a closed Traverse. Adjustment of closing error, correction for local attraction.	
III.	**Levelling and its application**		12
	3.1	Introduction to levelling, basic terms and definitions, types of instruments, construction and use of dumpy level, auto level, digital level and laser level in construction industry, principle axes of dumpy level, temporary and permanent adjustments	
	3.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon, corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	3.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors, difficulties in levelling work, corrections and precautions in levelling work.	

IV.	**Plane Tabling, Contouring, Area and Volume**		**08**
	4.1	**Plane Table Surveying:** Definition, principles, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying, Errors in plane table surveying, Use of telescopic alidade	
	4.2	**Contouring**: definitions, contour interval, equivalent, uses and characteristics of contour lines, direct and indirect methods of contouring. Grade contour: definition and use.	
	4.3	**Area**: Area of an irregular figure by trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods. Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	4.4	**Volume**: Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plans	
V.	**Theodolite Traversing**		**10**
	5.1	Various parts and axis of transit, technical terms, temporary and permanent adjustments of a transit, horizontal and vertical angles, methods of repetition and reiteration.	
	5.2	Different methods of running a theodolite traverse, Latitudes and departures, rectangular coordinates, traverse adjustments by Bowditch's, transit and modified transit rules, Gales Traverse Table, Numerical Problems	
	5.3	Use of theodolite for various works such as prolongation of a straight line, setting out an angle, bearing measurements. Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing; Trigonometrical Levelling: Problems on one plane and two plane methods,	
VI.	**Tacheometric surveying**		**06**
	6.1	Principle, purpose, uses, advantages and suitability of tacheometry, different methods of tacheometry, stadia formula, Stadia diagram and tables. Sub-tense bar method	
	6.2	Application in plane table and curve setting.	
	6.3	Radial Contouring	
		Total	**52**

Contribution to Outcomes

On completion of the course, the learners will be able to:

- Apply principles of surveying and leveling for civil engineering works
- Measure vertical and horizontal plane, linear and angular dimensions to arrive at solutions to basic surveying problems.
- Perform various practical and hence projects using different surveying instruments.
- Apply geometric principles for computing data and drawing plans and sections
- Analyze the obtained spatial data and compute areas and volumes and represent 3D data on plane surfaces (2D) as contours

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination will be conducted in conjunction with the practical/s and will be based on the entire syllabus and the term work. The weightage of the practical examination will be of 10 marks and that of oral, 15 marks.

List of Practical:

1. Computing area of polygon by chaining, ranging and offsetting and verify distances by EDM
2. Measuring bearing of closed traverse using Prismatic/Surveyor's compass and computing included angle.
3. Simple and differential levelling using dumpy level
4. Transferring R.L from benchmark to new point by auto level/digital level with at least three change points and performing check levelling
5. Measurement of horizontal angle by Repetition and Reiteration Method using Vernier Transit theodolite.
6. To find the constants of a tachometer and to verify filed distances.
7. To find R.L and distances by tachometric surveying.

8. To find height of inaccessible tower using one plane and two plane methods using Vernier Transit theodolite.
9. Plane table surveying by various methods with at least four stations.
10. Determination of areas of irregular figures by conventional/digital planimeter

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work:

It shall consist of the following:

- Field book based on afore-mentioned practicals conducted on and off the field.
- The account of practical performed with aim, apparatus, observations, calculations, results and inferences.
- The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical	:	10 marks
Attendance (Theory and Practical)	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Surveying and Leveling: Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
2. Surveying and Levelling: *N.N.Basak*, Tata McGraw Hill, New Delhi.
3. Surveying: *R. Agor*, Khanna Publishers.

4. Surveying: Vol-I: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling (2nd Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling (Vol.-I): *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling (Vol.-I): *S.K. Duggal*, Tata Mc-Graw Hill
8. Textbook of Surveying, By *C Venkatramaiah*, University Press, Hyderabad, Latest Edition

Web Materials:

1. http://nptel.ac.in/courses/105107122/

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 303	Strength of Materials	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

There are different types of structures made up of different materials such as concrete, steel, metals and timber. They are subjected to various types of loading/ forces such as axial, shear, bending and torsion. This subject equips the students to analyze the internal behavior of material of the structural members under different types of loading. The knowledge gained in this subject is helpful to study other subjects like Structural Analysis and Structural Design.

Objectives

- To study the engineering properties of the materials and solids and analyze the same to evaluate the stress –strain behaviour.
- To analyze the internal forces for the statistically determinate and compound beams having internal hinges with different types of loading.
- To understand the concept and behaviour of flexural members (beams) in flexure and shear, solid circular shaft for torsion, thin shells for internal stresses.
- To introduce the concept of strain energy for axial, flexure, shear and torsion.
- To study the behaviour of axially loaded columns and struts using different theories available for the analysis with various end conditions.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**1. Simple Stresses and Strains**		**08**
	1.1	Stresses, Strains, Modulus of elasticity (E), Modulus of rigidity (G), Bulk Modulus (K), Yield Stresses, Ultimate Stress, Factor of safety, shear stress, Poisson's ratio.	
	1.2	Relationship between E, G and K, bars of varying sections, deformation due to self- weight, composite sections, temperature stress.	
II.	**2. Shear Force and Bending Moment in Beams**		**06**
	2.1	Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading.	
	2.2	Relationship between rate of loading, shear force and bending moment.	
III.	**3. 1 Theory of Simple Bending**		**07**
	3.1.1	Moment of inertia, transfer theorem, polar moment of inertia	
	3.1.2	Flexure formula for straight beam, simple problems involving application of flexure formula, section modulus, moment of resistance, flitched beams.	
	3.2Strain Energy		**03**
	Strain energy due to axial force, stresses in axial member and simple beams under impact loading.		
IV.	**4.1. Shear Stresses in Beams**		**06**
	Distribution of shear stress across plane sections commonly used for structural purposes.		
	4.2 Theory of Simple Torsion		**06**
	4.2.1	Torsion in circular shafts-solid and hallow, stresses in shaft when transmitting power	
	4.2.2	Concept of equivalent torsional and bending moment	
V.	**5.1 Direct and Bending Stresses**		**05**
	Application to member's subjected to eccentric loads, core of section, problems on chimneys, retaining walls, dams, etc. involving lateral loads.		
	5.2 Columns and Struts		**04**
	Members subjected to axial loading, concept of buckling, Effective length, Euler's formula for columns and struts with different support conditions, Limitation of		

	Euler's formula, Rankine's formula, Problems based on Euler's and Rankine's formulae.	
VI.	**6.1 Principal Planes and Stresses**	**04**
	General equation for transformation of stress, principal planes and principal stresses, maximum shear stress, stress determination using Mohr's circle.	
	6.2 Thin Cylindrical and Spherical Shells	**03**
	Thin Cylindrical and spherical shells under internal pressure.	
	Total	**52**

Contribution to Outcomes

On completion of the course, the students will be able to:

- Understand and determine the engineering properties for metals and non-metals.
- Understand the concepts of shear force, bending moment, axial force for statically determinate beams and compound beams having internal hinges; and subsequently, its application to draw the shear force, bending moment and axial force diagrams.
- Analyze the flexural members for its structural behavior under the effect of flexure (bending), shear and torsion either independently or in combination thereof.
- Study the behavior of the structural member under the action of axial load, bending and twisting moment.
- Study the deformation behavior of axially loaded columns having different end conditions and further, evaluate the strength of such columns.

The successful completion of the course will equip the students for undertaking the courses dealing with the analysis and design of determinate and indeterminate structures.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4−5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an internal choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt anythree questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and the report of the experiments/ practicals conducted by the students including assignments.

List of Practicals:

1. Tension test on mild steel bars (stress-strain behavior, Young's modulus determination)
2. Tests on Tor Steel (Tension, bend and re-bend)
3. Transverse Test on cast iron.
4. Shear Test on mild steel, cast iron, and brass.
5. Torsion Test on mild steel and cast iron bar.
6. Brinell Hardness test (any three metal specimen)
7. Rockwell Hardness test on mild steel.
8. Izod / Charpy impact test (any three metal specimen)

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 Marks
Assignments : 10 Marks
Attendance : 05 Marks
Total : 25 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and JaanKiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and NillanjanMallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 304	Engineering Geology	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Geology is the study of earth, the minerals and rocks of which it is made. The study of the structures presents in the rocks and the effects of the natural forces acting upon them is essential to understand by civil engineers because all work performed by them involves earth and its features. The study helps to understand the causes and prevention of many geological activities like earthquakes, landslides and volcano. For a civil engineering project like dams, bridges, buildings etc. to be successful the engineers must understand the foundation rock and their structures, it also helps them to examine rocks for important metals, oil, natural gas and ground water.

Objective

- To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
- To study of 'Theory of Plate Tectonics' which helps to explain much of the global-scale geology including the formation of mountains, oceans, different landforms and the occurrence and distribution of earthquakes, volcanoes, landslides etc.
- To study minerals and rocks in detail in order to understand their origin, texture, structure and classification which is helpful to comment on suitability of rock type for any civil engineering project
- To study structural geology in order to understand deformational structures like fold, fault, joint, etc. and the forces responsible for their formation.
- To study methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.

- To study ground water zones, factors controlling water bearing capacity of rocks, geological work of ground water and techniques of recharge of groundwater.

Detailed Syllabus			
Module	**Sub-Modules/Contents**		**Periods**
I.	**Introduction**		**6**
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth, Theory of Plate Tectonics.	
	1.3	Agents modifying the earth's surface, study of weathering and its significance in engineering properties of rocks like strength, water tightness and durability etc.	
	1.4	Brief study of geological action of river, wind, glacier, ground water and the related land forms created by them.	
	1.5	Building stones**-** Requirements of good building stones and its geological factors, controlling properties, consideration of common rocks as building stones, study of different building stones from various formations of Indian Peninsula.	
II.	**Mineralogy and Petrology**		**7**
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, Classifications, study of commonly occurring igneous rocks and their engineering application.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., residual deposits, chemically and organically formed deposits, classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, metamorphic minerals, rock cleavage, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	

III.	**Structural Geology, Stratigraphy and Indian Geology**		**7**
	3.1	Structural elements of rocks, dip, strike, outcrop patterns, outliers and inliers, study of joints, unconformities and their engineering consideration. Faults and folds, their classification and importance in engineering operations.	
	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province	
IV.	**Geological Investigation, study of dam and reservoir site:**		**7**
	4.1	Preliminary Geological Investigation and their importance to achieve safety and economy of the projects like dams and tunnels, methods of surface and subsurface investigations, Excavations-Trial pit, trenches etc.	
	4.2	Core Drilling - Geological logging, Inclined Drill holes. Electrical Resistivity method, Seismic method and their applications	
	4.3	Strengths, stability, water tightness of the foundation rocks and its physical characters against geological structures at dam sites, favourable and unfavourable geological conditions for locating dam sites.	
	4.4	Precautions over the unfavourable geological structures like faults,dykes, joints, unfavourable dips on dam sites and giving treatments, structural and erosional valleys.	
V.	**Tunnel Investigation and Ground Water Control**		**7**
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions, Difficulties during tunneling and methods to overcome the difficulties. Methods of tunneling in soft soil	
	5.2	Sources, zones, water table, unconfined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Cone of depression and its use in Civil engineering. Artesian well (flowing and non-flowing)	
	5.3	Springs seepage sites and geological structures. Different types of rocks as source of ground water	
	5.4	Methods of artificial recharge of ground water, geology of percolation tank.	
VI.	**Geological Disasters and Control Measures**		**5**
	6.1	**Landslides-** Types, causes and preventive measures for landslides, Landslides in Deccan region	

	6.2	**Volcano-** Central type and fissure type, products of volcano and volcanic land forms.	
	6.3	**Earthquake-** Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory Preventive measures for structures constructed in Earthquake prone areas.	
		Total	**39**

Contribution to Outcomes

On completion of the course, the students shall be able to:

- Understand the significance of geological studies for safe, stable and economic design of any civil engineering structure.
- Demonstrate the knowledge of geology to explain major geological processes such as formation of mountain, ocean and the occurrence and distribution of earthquakes and volcanoes.
- Explain various geological structures like folds, faults, joints, unconformity, their origin and distribution which are very essential in the design and construction of dams, tunnels and any other major civil engineering project.
- Understand methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.
- Understand the causes and prevention of natural hazard like earthquake, landslide, volcano etc. will help student to meet the specific needs with suitable considerations for public health and safety.
- Prepare effective reports mentioning advantages and disadvantages caused due to geological condition and can evaluate any site for civil engineering project.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

Oral examination will be based on the entire syllabus and a neatly written report for the practical along with a report of the site visit.

List of Practicals:

1. Study of physical properties of the minerals.
2. Identification of minerals- Quartz and its varieties, Orthoclase, Plagioclase, Muscovite, Biotite, Hornblende, Asbestos, Augite, Olivine, Tourmaline, Garnet, Actinolite, Calcite, Dolomite, Gypsum, Beryl, Bauxite, Graphite, Galena, Pyrite. Hematite, Magnetite, Chromite, Corundum, Talc, Fluorite, Kyanite.
3. Identification of rocks: ***Igneous rocks-***Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic tuffs. ***Sedimentary Rocks-*** Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites. ***Metamorphic Rocks-*** Mica Schists, Hornblende Schists, Slate, Phyllite, Granite Gneiss, Augen gneiss, Marbles and Quartzite.
4. Study of Geological maps (At least 5).
5. Study of core samples, RQD, Core logging.
6. At least two engineering problems based on field data collected during site investigation.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term work shall consist of the:

1. Report of the practical conducted in terms of the study of the physical properties of the minerals, identification of minerals and rocks.
2. Report of the Geological maps.
3. Report of the two problems based on field data.
4. At least *six* assignments covering entire syllabus

Site Visit:

There shall be a visit to get the geological information according to the various contents mentioned in the syllabus. The students shall prepare a detail report along with the summarized findings. The report will form a part of the term work.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 marks
Assignments : 07marks
Site Visit Report : 03 marks
Attendance : 05 marks
Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.
75% – 80%: 03 Marks; 81% – 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Text book of Engineering Geology: *Dr. R. B. Gupte*, Pune VidyarthiGrihaPrakashan,Pune.
2. Text book of Engineering Geology: *P. K. Mukerjee*, Asia.
3. Text book of Engineering and General Geology: *Parbin Singh*, Carson Publication.
4. Text book of Engineering Geology: *N. Chenna, Kesavulu*, Mc-Millan.
5. Principles of Engineering Geology: *K. M. Banger*.

Reference Books:

1. Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
2. Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
1. Principles of Geomorphology: *William D. Thornbury*, John Wiley Publications, New York.
2. Geology for Civil Engineering: A. *C. McLean, C.D. Gribble, George Allen &Unwin*London.
3. Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 305	Fluid Mechanics–I	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science of fluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics with their applications in fluid flow problems.

Course Objectives

Students are introduced to:

- Properties of fluids and basic concepts applicable to fluid mechanics and its relevance in civil engineering.
- Fundamentals of hydrostatics viz. Pascal's law, hydrostatic law and determination of hydrostatic pressure and centre of pressure of surfaces.
- Principle of buoyancy and its application
- The concept of fluid kinematics and ideal fluid flow.
- Concepts of control volume, control surface and dynamics of fluid flow.
- Various flow measuring devices and their applications

Detailed Syllabus			
Module	**Sub-Module / Contents**		**Periods**
I.	**1. Properties of Fluids**		**03**
	Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, basic concepts applicable to fluid mechanics		
II.	**2. Fluid Statics**		**10**
	2.1	**Pressure measurement:** Pascal's law, hydrostatic law, pressure variation in fluids at rest. Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	**Hydrostatic force on surfaces:** Total pressure and centre of pressure, total pressure on horizontal plane surface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	**Buoyancy and flotation:** Archimedes principle, Meta-centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
III.	3. **Liquids in Relative equilibrium & Fluid Kinematics**		**08**
	3.1	**Liquids in Relative equilibrium** Fluid mass subjected to uniform linear acceleration, liquid containers subjected to constant horizontal acceleration and vertical acceleration, fluid containers subjected to constant rotation with axis vertical and horizontal.	
	3.2	**Fluid Kinematics** Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, velocity potential and stream function, streamline, streak line, path line, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity.	
IV.	**4. Introduction to Ideal flow.**		**04**
	Introduction to ideal fluid flow, uniform flow, source and Sink, free vortex flow, superimposed flow, doublet, Flow past a half body, flow past a Rankine oval body and flow past a cylinder		

V.	**5. Fluid dynamics**		06
	Control volume and control surface, Forces acting on fluid in motion, NavierStokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, rotameter.		
VI.	**6. Flow measurement**		08
	6.1	**Orifices and Mouthpieces:** Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	6.2	**Notches and Weirs:** Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolleti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
		Total	39

Contribution to Outcomes

On completion of this course the student will be able to:

- Define various properties of fluids, state and explain different types of laws and principles of fluid mechanics.
- Interpret different forms of pressure measurement and Calculate Hydrostatic Force and its Location for a given geometry and orientation of plane surface.
- Compute force of buoyancy on a partially or fully submerged body and analyse the stability of a floating body.
- Distinguish velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
- Derive Euler's Equation of motion and Deduce Bernoulli's equation.
- Measure velocity and rate of flow using various devices.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

List of Experiments (Any six):

1. Determination of metacentric height.
2. Verification of Bernoulli's theorem.
3. Determination of coefficient of discharge through Venturimeter.
4. Determination of coefficient of discharge through Orifice meter.
5. Determination of coefficient of discharge through Nozzle meter.
7. Determination of coefficient of discharge through Notches (Rectangular and Triangular notch).
8. Determination of coefficient of discharge over weirs (Broad Crested weir and Ogee weir).
9. Determination of hydraulic coefficients of orifice.
10. Determination of coefficient of discharge through mouthpiece.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 Marks

Assignments : 10 Marks

Attendance : 05 Marks

Total : 25 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% – 80%: 03 Marks; 81% – 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr. P.M. Modi and Dr. S.M. Seth*, Standard Book House, Delhi
3. Theory and Application of Fluid Mechanics: *K. Subramanian*, Tata McGraw hill publishing company, New Delhi.
4. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
5. Fluid Mechanics and Hydraulics: *Dr. S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar*, F.K. Kataria and sons
7. Fluid Mechanics: *R.K. Bansal,*Laxmi Publications (P) Ltd.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications*: R.L. Daugherty, J.B. Franzini, E.J. Finnemore*, Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: *Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer*. Oxford Higher Education.

Semester IV

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 401	Applied Mathematics–IV	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To inculcate an ability to relate engineering problems to mathematical context
- To provide a solid foundation in mathematical fundamentals required to solve engineering problem
- To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
- To prepare students for competitive exams

Detailed Syllabus			
Module		**Sub-Modules/ Contents**	**Periods**
I.		**1. Matrices**	**08**
	1.1	Brief revision of vectors over a real field, inner product, norm of a vector	
	1.2	Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof). Similarity of matrices. Functions of a square matrix	
II.		**2. Matrices**	**09**
	2.1	Minimal polynomial and Derogatory matrix.	
	2.2	Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors	
	2.3	**Vector calculus** Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function.	
	2.4	Line integrals, circulation of a vector, condition for independence of the path in the line integral.	
III.		**3. Vector calculus**	**09**
	3.1	Green's theorem (without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions. (No verification problems on Stoke's Theorem and Gauss Divergence Theorem), Linear Programming problems.	
	3.2	Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P.	
IV.		**4. Linear Programming Problems Probability Distributions**	**09**
	4.1	Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P., Probability Distributions	
	4.2	Discrete and Continuous random variables, Probability mass and density	

		function, Probability distribution for random variables, Expected value, Variance.	
	4.3	Probability Distributions: Binomial, Poisson and Normal Distributions.	
V.	**5. Sampling theory**		**09**
	5.1	Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples.	
	5.2	Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples.	
	5.3	Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	
VI.	**6. Sampling theory and ANOVA**		**08**
	6.1	Chi-square test, Test for the Goodness of fit, Association of attributes and Yate's correction	
	6.2	Analysis of Variance(F-Test): One-way classification, Two-way classification (short-cut method)	
		Total	**52**

Contribution to Outcomes

After learning the topics, the students will be able to:

- Solve the system of linear equations using matrix algebra with its specific rules
- Demonstrate basics of vector calculus
- Apply the concept of probability distribution and sampling theory to engineering problems
- Apply principles of vector calculus to the analysis of engineering problems
- Identify, formulate and solve engineering problems
- Illustrate basic theory of correlations and regression

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to write at least 6 class tutorials on entire syllabus.

Recommended Books:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 402	Surveying–II	4.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	03	-	03	1.5	-	4.5

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	50	-	25	175

Rationale

This is an advanced course which intended to teach students modern surveying instruments with their principles and uses in surveying along with curves and setting out of different civil engineering works. Students are exposed to the concept of Total Station, G.P.S., G.I.S. and remote sensing techniques. To make the students acquainted with the field problems, a 4-day survey camp is arranged to execute the Road project, Block contouring project, Tachometric project and Total Station Traversing at ideal locations.

Objectives

- To understand operation of Total Station, EDM, Electronic Theodolite for desired accuracy in surveying.
- To learn how to establish survey control of determined accuracy using GPS, GIS and Remote sensing.
- To Study various types of curves by linear and angular methods.
- To prepare different layout from surveying data.
- To learn how to generate and manipulate field survey data and incorporate design data using specialized softwares.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Curves-Horizontal**		10
	1.1	Definitions of different terms, necessity of curves and types of curves	
	1.2	Simple circular curves, office and field work, linear and angular methods of setting out simple circular curves, problems on simple circular curve, compound curves, their needs and various types	
	1.3	Reverse and transition curves, their properties and advantages, design of transition curves, shift, spiral angle. Composite curves office and field work. Setting out of curves by angular method, composite curves problems.	
	1.4	Difficulties in setting out curves and solution for the same.	
II.	**Curves-Vertical**		3
	2.1	Tangent correction and chord gradient methods, , problems on the same	
	2.2	Sight distance on a vertical curve, problems on the same	
III.	**Setting out works**		4
	3.1	General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite	
	3.2	Setting out a foundation plans for building, sewer line, culvert, and use of laser for works; Setting out centre line for tunnel, transfer of levels for underground works.	
	3.3	Project/route survey for bridge, dam and canal;Checking verticality of high rise structures.	
IV.	**Special Survey Instruments**		6
	4.1	**Electronic Theodolite, Total Station**: Principles, Types, Applications, Topographical Survey and Stake-out, Transferring data to and from other software’s for further processing, advantages and limitations	
	4.2	Introduction to Site square, Penta Graph, Auto-set Level, Transit level, Special Compasses, Brunton’s Universal Pocket Transit, Mountain Compass Transit	

V.	**Modern Methods of Surveying**		12
	5.1	**Global Positioning System (GPS):**Basic principles, GPS segments, receivers, computations of coordinates, Applications in surveying	
	5.2	**Remote Sensing**: Definition, basic concepts, electromagnetic radiation and spectrum, energy source and its characteristics, image acquisition and image interpretation. Application of remote sensing.	
	5.3	**Geographical Information System (GIS)**: Geographical concepts and terminology, advantages, basic components of GIS, data types, GIS analysis, Applications of GIS.	
	5.4	**Field Astronomy**: Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.	
	5.5	**Aerial photogrammetry**: Introduction, Principle, Uses, Aerial camera, Aerial photographs, Definitions, Scale of vertical and tilted photograph, Ground Co-ordinates, Displacements and errors, Ground control, Procedure of aerial survey, Photomaps and mosaics, Stereoscopes, Parallax bar	
	5.6	**Hydrographic Survey:** Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders.	
VI.	**Cadastral Surveying**		4
	6.1	Interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property. Legal requirements relating to property boundary surveys in India	
	6.2	Role of revenue department in maintaining survey records, introduction to local survey terminologies like tehsildar, 7/12, utara, namuna8, etc. Introduction to Survey of India Department; Department of Registration and Stamps, Maharashtra	
		Total	**39**

Contribution to Outcomes

On completion of the course, the learners will be able to:

- Operate Total Station & GPS for desired accuracy in surveying and establish survey control of determined accuracy using Total Station, GPS, GIS and remote sensing.
- Set out various types of curves by linear and angular methods
- Compute setting out data from survey and design information.
- Generate and manipulate field survey data and incorporate design data using specialised software's.
- Appreciate the role of various governmental authorities in maintaining cadastral survey records.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus, the projects performed and practicals conducted. It will include a practical exam (10 marks) before proceeding for viva (15 marks)

List of Practicals:

1. To set out circular curve by linear methods.
2. To set out circular curve by angular methods.
3. Determination of horizontal and vertical distances, bearings and area using Total Station.
4. Determination of co-ordinates of a traverse, length of traverse lines using GPS
5. Post-processing of data obtained in Total Station & GPS practical using softwares like *TERRAMODEL*, *AutoCAD* etc. and print out the sheets
6. Analysis of survey projects conducted using computer by applying various softwares like MS excel, SurveyOS, surfit, QuikGrid, etc.
7. Setting out a simple foundation plan in the field.

Internal Assessment:

There will be two class tests (to be referred to as an ‘Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work

It shall consist of the following:

1. **Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, Profile levelling, cross-sectioning, at least one simple and one reverse curve, plotting of L section and Cross Section. (Two full imperial sheet including plan, L–section and any three typical Cross-sections, sample data computation for curves, cutting and filling required
2. **Project II**: Block Contouring project using Auto level for minimum 100 × 80 m area and generating contours by MS Excel, etc. (minimum contour interval 0.2 meter)
3. **Project III:** Tachometric contouring project on hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours using software such as Autodesk land desktop, Auto civil, Foresight etc. (minimum contour interval 1 meter)
4. **Project IV:** Traversing using a total station (minimum 10 acres’ area)
5. The account of practicals performed with aim, apparatus, observations, calculations, results and inferences
6. Field book submission on afore-mentioned practicals conducted on and off the field.
7. The assignments shall comprise of the minimum 5 problems covering the entire syllabus, theory questions on each chapter

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments.Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical performance	:	15 marks
Project (04)	:	20 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**50 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Surveying: *R. Agor*, Khanna Publishers, New Delhi
2. Surveying and Levelling: *N N. Basak*, Tata McGraw Hill, New Delhi.
3. Surveying and Levelling, Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
4. Surveying, Vol-I, II & III: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling, (2Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling, Vol.-I, II & III: *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling, Vol.-I& II:*S. K.Duggal*, Tata Mc-Graw Hill
8. Advanced Surveying, *R. Agor*, Khanna Publishers, New Delhi
9. Fundamentals of Surveying, *S.K. Roy*, Prentice Hall India, New Delhi
10. Remote Sensing and GIS, *B Bhatta*, Oxford University Press, New Delhi.
11. Remote sensing and Image interpretation, *T.M Lillesand, R.W Kiefer andJ.W Chipman*, 5th edition, John Wiley and Sons India
12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. &Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002
13. Remote Sensing and Geographical Information Systems. *Anji Reddy*, B.S.Publications, Hyderabad, 2001.

Web Materials:

1. http://nptel.ac.in/courses/105104100/1
2. http://www.surveyofindia.gov.in/
3. http://igrmaharashtra.gov.in/#

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 403	Structural Analysis–I	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

There are various types of the components of any civil engineering structures which are subjected to different types of loading or combination thereof. Most of the structures which are analyzed for finding its structural response which would form the basis for its structural design are indeterminate structure. Notwithstanding, the structural analysis of any civil engineering structural systems idealizing the same as the statically determinate one shall be the foundation of the analysis of the indeterminate structures. The knowledge gained in the subjects such as engineering mechanics and strength of materials in the preceding semesters where students have been exposed to the principles of engineering mechanics and subsequently, its application on the materials and solids to study its behavior under the action of loads and further to evaluate its strength properties, is extended in this subject for the analysis of various structural systems such as beams, frames, arches and suspension bridges.

Objectives

- To analyze the statically determinate simple portal frame (both- rigid jointed and having an internal hinges).
- To study the methods and evaluating rotation and displacement parameters in respect of beams and frames using various methods.
- To analyze the three hinged arches; and cables, suspension bridges and three hinged stiffening girder.
- To study the buckling behavior of the axially and transversely loaded beam-columns and its analyses.
- To understand the concept and behavior of the beam and trusses under rolling loads and subsequently, to obtain the absolute maximum bending moment.
- To understand the concept of unsymmetrical bending and shear center and its application in solving the problems of structural mechanics.

Detailed Syllabus

Module	Sub- Modules/ Contents	Periods
I.	**1.1 Axial force, shear force and bending moment**	6
	Concept of statically determinate structures; Axial force, shear force and bending moment diagrams for statically determinate frames with and without internal hinges.	
	1.2. General theorems and its application to simple structures	3
	General theorems and principles related to elastic structures, types of strain energy in elastic structures, complementary energy, principle of virtual work, Betti's and Maxwell's reciprocal theorems, Castigliano's first theorem, principle of superposition. Application of Energy Approach to evaluate deflection in simple structures such as simple beams, portal frame, bent and arch type structures, etc.	
II.	**2. Deflection of Statically Determinate Structures Using Geometrical Methods**	7
	Deflection of cantilever, simply supported and overhanging beams for different types of loadings Using-Integration Approach including Double Integration method and Macaulay's Method, Geometrical Methods including Moment area method and Conjugate beam method.	
III.	**3. Deflection of Statically Determinate Structures Using Methods Based on Energy Principle**	9
	3.1 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out slope and deflection in beams. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such structures.	
	3.2 Application of Unit Load Method (Virtual Work Method) for finding out deflection of rigid jointed frames. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such frames.	
	3.3 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out deflection in pin jointed frames (trusses). Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection intrusses.	
IV.	**4.1 Rolling Load and Influence Lines for Statically Determinate Structures**	8
	Influence lines for cantilever, simply supported, overhanging beams and pin jointed truss including warren truss, criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under moving loads (UDL and Series of point loads) for simply supported girder.	

	4.2 Three Hinged Elastic Arches	**5**
	Determination of normal thrust, radial shear and bending moment for parabolic and circular (semi and segmental) three hinged arches, Influence lines for normal thrust, radial shear and bending moment for three hinged parabolic arch.	
V.	**5. Cables, Suspension bridges and Three Hinged Stiffening Girder**	**4**
	Simple suspension cable, different geometries of cables, minimum and maximum tension in the cable supported at same/different levels, anchor cable, suspension cable with three hinged stiffening girder.	
VI.	**6.1 Columns and Struts**	**4**
	Columns and struts subjected to eccentric loads, Secant formula, Perry's formula, struts with initial curvature.	
	6.2 Unsymmetrical bending	**3**
	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	6.3 Shear Centre	**3**
	Shear centre for thin walled sections such as channel, tee, angle section and I-section.	
	Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Understand the behavior of various statically determinate structures including compound structures having an internal hinge for various loadings.
- Analyze these structures to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc.
- Evaluate the displacements / deflections in beams and frames under the action of loads. They will be able to obtain the response of the beams under the action of moving loads.
- Analyze the structures such as arches and suspension bridges and study the behavior of eccentrically loaded columns.
- Analyze the section with respect to unsymmetrical bending and shear center.
- Demonstrate the ability to extend the knowledge gained in this subject in the subjects *Structural Analysis-II* and elective subjects such as *Advanced Structural Analysis* and *Advanced Structural Mechanics* in the higher years of their UG programme where they will be dealing with the indeterminate structures. The knowledge gained in this subject shall also be useful for application in the structural design in later years.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments	:	20 Marks
Attendance	:	05 Marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: *S. B. Junnarkar and H.J. Shah*, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, *Vazirani and Ratwani*
4. Strength of Materials*: S. Ramamrutham,* Dhanpatrai and Publishers, Delhi
5. Theory of Structures: *S. Ramamrutham,* Dhanpatrai and Sons, Delhi
6. Structural Analysis I: *Hemant Patil, Yogesh Patil, Jignesh Patel*, Synergy Knowledgeware, Mumbai.
7. Strength of Materials*: Rajput*, S. Chand Publications, Delhi
8. Structural Analysis: *Bhavikatti*, Vikas publisher house Pvt, ltd.
9. Structural Analysis: *DevdasMenon*, Narosa Publishing House.
10. Basic Structural Analysis: K.*U. Muthu, Azmi Ibrahim, M. Vijyanand, MagantiJanadharnand. I.K.* International Publishing House Pvt. Ltd.
11. Comprehensive Structural Analysis: Vol-I and II by *Vaidyanathan R. and Perumal R.*Laxmi Publications.
12. Elementary Structural Analysis: *Jindal*
13. Structural Analysis: *L.S. Negi and R.S. Jangid,* Tata Mc-Graw Hill India
14. Fundamentals of Structural Analysis: *Sujit Kumar Roy and SubrotaChakrabarty*, S. Chand Publications.
15. Structural Analysis: *T.S. Thandavamoorthy*, Oxford University Press.
16. Structural Analysis: *Manmohan Das, Bharghab Mohan*Pentice Hall International.

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norries and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 404	Building Design and Drawing	3.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
02	03	-	02	1.5	-	3.5

Evaluation Scheme

Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	25	-	25	150

Rationale

Drawing is the language civil engineers communicate in. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

- To remember and recall the intricate details of building design and drawing.
- To gain an understanding of the basic concepts of building design and drawing.
- To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- To identify, analyse, research literate and solve complex building design and drawing problems.
- To design new solutions for complex building design and drawing problems.
- To effectively communicate ideas related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus

Module	Sub- Modules/ Contents		Periods
I.	**1. Principles and Codes of Practices for Planning and Designing of Buildings**		9
	1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings	
	1.2	Principles of planning for residential buildings	
	1.3	Classification of buildings	
	1.4	Study of building Bye-laws and documents / permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
	1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
	1.6	Calculation of setback distances, carpet area, built-up area and floor space index (FSI)	
	1.7	Principles of planning for public buildings: i) Building for education: schools, colleges, institutions, libraries etc. ii) Buildings for health: hospitals, primary health centres etc. iii) Office buildings: banks, post offices, commercial complexes etc. iv) Building for public residence: hostels, boarding houses etc.	
II.	**2. Components and Services of a Building**		5
	2.1	Staircase (dog legged & open newel in details),	
	2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
	2.3	Openings: doors and windows	
	2.4	Types of pitched roof and their suitability (plan and section)	
	2.5	Building services: Water supply, sanitary and electrical layouts	
III.	**3. Perspective Drawing**		4
	3.1	One-point perspective	
	3.2	Two-point perspective	
IV.	**4. Town Planning, Architectural Planning & Built Environment**		4
	4.1	Objectives and principles (road systems, zoning, green belt etc.)	
	4.2	Master plan and slum rehabilitation	
	4.3	Architectural Planning: introduction and principles	

	4.4	Built Environment: introduction and principles	
V.	**5. Green Buildings**		**2**
	5.1	Introduction and overview	
	5.2	Certification methods (LEED and TERI)	
VI.	**6. Computer Aided Drawing (CAD)**		**2**
	6.1	Advantages of CAD	
	6.2	Overview of any one of the CAD software's prevailing in the market (AutoCAD, Revit, 3D Max etc.)	
		Total	**26**

Contribution to Outcomes

- Students will be able to list down the types of structures and its various components (for eg. doors, windows, staircase, foundations etc.)
- Students will be able to explain various concepts pertaining to building design and drawing (for eg, principles of planning, architectural planning, green buildings etc.)
- Students will be able to apply principles of planning, architectural planning and building bye laws while designing and preparing building drawings.
- Students will be able to calculate and analyze various technical details of a building (for eg. carpet area, FSI etc.) from its drawings.
- Students will be able to design various components of buildings (for eg. staircases etc.) as well as buildings as a whole, given the requirements of the building owner and local D.C. laws.
- Students will be able to prepare drawings (for eg. plans, elevation, perspective views etc.) of the designed components of buildings as well as buildings as a whole.

Theory Examination:

1. Question paper will consist of total 6 questions; each carrying 20 marks.
2. Question no. 1 will be compulsory and based on drawing work of any one building, maybe residential or public building
3. Any 3 out of the remaining 5 questions need to be attempted.
4. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Practical Examination (Oral and Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment') to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work

Reports:

1. Summary of Development Control (D.C.) rules of student's own or nearest city
2. Summary of documents required from commencement to completion of the building by the concerned local body i.e. Municipal Corporation or nearest Municipality.
3. One-day site visit could be arranged for students to visit any one public building near the college like commercial complex, library, Bank etc. They need to study in detail of that building take the measurements of that building should submit as a site report with detailed drawing according to some suitable scale. This will become a part of Term Work.

Drawings:

1. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a residential building (bungalow or apartment) to be constructed as a (G+1) R.C.C. framed structure
2. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a public building (school or hostel or hospital or bank) be constructed as a (G+1) R.C.C. framed structure
3. Roof plan, foundation plan (with section of a typical foundation), plan and section of staircase, one typical door and one typical window of either one of the two above drawings
4. One point and two-point perspective
5. CAD sheet of either one of the first two drawings

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Drawing Sheets : 10 Marks
Report of the Drawing : 05 Marks
Report on the Site Visit : 05 Marks
Attendance : 05 Marks
Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S. Y. Patki* (Tata McGraw-Hill Education)
2. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)
3. Planning and Designing Buildings by *Y.S.Sane* (Modern Publication House, Pune)
4. Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C.V.Vijayan* (SPADES Publication, Calicut)
5. Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in/documents/10180/7761832/5.pdf/e09991a2-b29e-4e04-a33e-a40aca6e2689?version=1.1)
4. Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5. Development Plan and Control Regulation for 27 villages of Kalyan and Ambernath tehsils of Thane district, Maharashtra (https://mmrda.maharashtra.gov.in)

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 405	Building Materials and Construction Technology	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This subject provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing. This subject is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building construction system so that student can effectively plan and execute building construction work.

Objectives

- To study the manufacturing process, properties, and use of different types of building materials like cement, lime, mortar, concrete, stone, brick, timber, including materials such as paints and varnishes used for treatment of the surfaces so as to achieve good knowledge about the building materials.
- To enable the students to identify various components of building masonry, roof and floor, staircase etc., their functions and methods of construction so as to achieve good knowledge about building construction.
- To study the properties such as workability, durability and porosity of fresh and hardened concrete.
- To understand the concept and optimization of mix design for different environmental conditions.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Introduction** Classification of materials, building materials symbols and requirements of building materials and products: functional, aesthetical and economical		4
II.	**Manufacturing Process and Properties of Basic Construction Materials.**		11
	2.1	Rocks (Stone) quarrying, milling and surface finishing, preservative treatments. **Aggregate**-Properties of coarse and fine aggregates and their influence on properties of concrete, properties of crushed aggregates.	
	2.2	**Structural clay products** -bricks, roofing tiles, ceramic tiles, raw materials and manufacturing process.	
	2.3	Concrete blocks, flooring tiles, paver blocks -raw materials and manufacturing process.	
	2.4	**Binder material**: lime, cement: Manufacturing process and physical properties, plaster of Paris -properties and uses.	
	2.5	**Mortar** -ingredients, preparation and uses.	
	2.6	Damp -proofing and water proofing materials	
III.	3.1	**Concrete**	09
		Grades of concrete, Manufacturing process, Properties of fresh and hardened concrete. Durability -Factors affecting durability, Relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test.	
	3.2	**Admixtures**: Plasticizers, Super-plasticizers, Retarders, Accelerators, Mineral admixtures and other admixtures, test on admixtures, chemistry and compatibility with concrete.	
IV.	4.1	**Glass**: Types and uses. Introduction to glass fibre reinforced plastic.	04
	4.2	**Timber**: Varieties, defects in timber, preservative treatments and wood composites.	
V.	5.1	**Concrete mix design** Types of mix, Mix design for compressive strength by I.S. method, Mix design for flexural strength, Method of determining compressive strength of accelerated - cured concrete test specimens as per IS:9013-2004 (revised code)	10

	5.2	**Ready mix concrete**: Advantages of RMC, components of RMC plant, distribution and transport, handling and placing, mix design of RMC, Mass Concerting, Vaccum Concerting and Concreting Equipments	
VI.	6.1	**Masonry Construction and Masonry Finishes**: Classification and bonding of stone, brick and concrete blocks Masonry finishes -pointing, plastering and painting	**14**
	6.2	**Formwork** Materials used, design considerations, shuttering, centering and staging, scaffolding. Types of form work: Slip form work, Cantilever and other modern form work	
	6.3	**Floor and roof** Different types and its suitability. Type of roofs, wooden and steel trusses and roof covering Different types of cladding.	
		Total	**52**

Contribution to Outcomes

On completion of the course, the students will be able to:

- Identify and list the various building materials, their properties and symbols.
- Identify the properties of ingredients of concrete, interpret and design concrete mix for various grades.
- Explain and interpret manufacturing process of basic construction materials and understand various masonry construction and finishes.
- Perform tests on various materials.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).

5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practicals conducted by the students and a detail report of the industrial/ site visit.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

List of Practicals*(Any Eight to be performed)*:

1. Physical properties of cement: Fineness, consistency, setting time, Soundness, Compressive strength.
2. Water absorption and compressive strength test of bricks.
3. Water absorption and transverse load test on tiles.
4. Compression test on timber (Parallel/ perpendicular to the grains).
5. Effect of w/c ratio on workability, (slump cone, compaction factor, V-B test, flow table) and strength of concrete
6. Effect of w/c ratio on strength of concrete,
7. Study of admixtures and their effect on workability and strength of concrete
8. Secant modulus of elasticity of concrete and indirect tensile test on concrete
9. Nondestructive testing of concrete- some applications (hammer, ultrasonic)
10. Mix design in laboratory.

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall study various aspects of the plant along with various operations. A visit may also be arranged to the site involving repairs and rehabilitation of concrete structures. The visit to any site where construction is going on may be arranged and the students may be made aware of the various construction activities. They shall prepare a report of the visit which shall include all above points. The same shall be evaluated by the concerned teacher.

Term Work:

The term work shall consist of:

- Report of minimum **08** experiments.
- Assignments, including at least **20** sketches on A2 size drawing sheets covering entire syllabus.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.

- Although minimum numbers of experiments and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments.Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 Marks

Assignments : 05 Marks

Sketches : 05 Marks

Attendance : 05 Marks

Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Building Construction: *S. P. Bindra and S. P. Arora*, Dhanpat Rai and Sons, Delhi.
2. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
3. Building Construction: *Rangwala*, Charotar Publications, Anand (Gujrat).
4. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
5. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
6. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman.
7. Concrete mix proportioning-guidelines (IS 10262:2009).
8. Concrete Technology: *A. R. Shanthakumar*, Oxford University Press.
9. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
10. Materials of Construction: *D. N. Ghose*, Tata McGraw Hill, Delhi.
11. Architectural Materials science*: D. Anapetor*, Mir Publishers.
12. Introduction to Engineering Materials: *B. K. Agrawal*, Tata McGraw Hill NewDelhi.
13. Engineering Materials: *P. Surendra Singh*, Vani Education Books New Delhi.
14. Building Materials (Products, Properties and Systems): *M.L. Gambhir and NehaJamwal*, Mc-Graw Hill Publications.
15. Specifications for different materials, BIS Publications, New Delhi
16. Properties of concrete: Neville, Isaac Pitman, London.
17. Relevant I.S. codes: Bureau of Indian standard.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 406	Fluid Mechanics–II	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme

Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study dealt with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

- To understand the Pipe flow problems, losses incurred during transmission of power through pipe and nozzle.
- To study hardy cross method and water hammer phenomenon
- To study and analyze the pipe network which will help to design water supply schemes.
- To study laminar, turbulent flows and its significance.
- To study compressible flow and understand boundary layer theory.

Detailed Syllabus

Module	Sub-module /Content		Periods
I	**1. Flow through pipes:**		**10**
	1.1	**Flow through pipes:** Loss of head through pipes, Darcy-Weisbach equation, minor and major losses. Hydraulic gradient line and energy gradient line, pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flow through branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer:** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures.	
II	**2. Flow through nozzles:**		**04**
	Power transmitted through nozzle, condition for maximum power transmitted, diameter of nozzle for maximum transmission of power.		
III	**3. Compressible flow:**		**05**
	Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties.		
IV	**4. Boundary layer theory:**		**07**
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerges body, drag and lift, terminal velocity of body		
V	**5. Laminar Flow:**		**05**
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving. Kinetic energy correction factor, and momentum correction factor. Dash pot mechanism.		
VI	**6. Turbulent Flow:**		**08**
	Causes of turbulence, shear stress in turbulent flow, Prandtl's mixing length Theory, Hydro dynamically smooth and rough pipes, velocity distribution in smooth and rough pipes, Karman-Prandtl velocity distribution equation, Resistance to flow in smooth and rough pipes, resistance equation and Moody's diagram.		
		Total	**39**

Contribution to Outcomes

- On completion of this course the student will be able to:
- Interpret different pipe fittings and evaluate the fluid velocity considering major and minor losses.
- Solve pipe network problems by Hardy cross method.
- Distinguish the types of compressible flow and understand concept of boundary layer theory.
- Evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation for laminar flow in a pipe.
- Establish Prandtl's mixing theory and solve turbulent flow problems.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and the report of the experiments conducted by the students including assignments.

List of Practicals (Any six experiments to be performed):

1. Reynold's Experiment
2. Determination of viscosity of fluid
3. Friction loss through pipes
4. Minor losses through pipes
5. Laminar flow through pipes
6. Velocity distribution in circular pipes
7. Turbulent flow through pipe
8. Water Hammer phenomenon

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report on Experiments : 10 marks

Assignments : 10 Marks

Attendance : 05 Marks

Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%–80%: 03 Marks; 81%–90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr P.M. Modi and Dr. S.M. Seth*, Standard book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company.
3. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar, F.K. Kataria.*
5. Fluid Mechanics and Hydraulics: *Dr. S. K. Ukarande*, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN 97893 8116 2538.
6. Fluid Mechanics: *R.K. Bansal* Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: *C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli*. Oxford Higher Education.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: *Streeter White Bed ford*, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: *R.L. Daugherty, J.B.Franzini, E.J., Finnemore*, Tata McGraw Hill New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India Pvt. Ltd., Delhi.

As per letter No. AA/ICD/20
.780. dt. 12/12

UNIVERSITY OF MUMBAI
No. UG/44 of 2018-19

Again Revised syllabus
as per letter No. AAU/ICD/
2018-19/890 dt. 15.2.19.

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/248 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.55 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. in Civil Engineering (Sem - V & VI) has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
25th June, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.55/05/05/2018

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No. UG/44 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

Dean, Faculty of Science and Technology

Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development. Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, semester-based credit and grading system is also introduced to ensure quality of engineering education. Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scales to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017- 18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Dean(I/c) Faculty of Science and Technology,

Member - Academic Council,

University of Mumbai, Mumbai

Chairman

Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education in the process of curriculum development. As the Chairman, Board of Studies in Civil Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The Program Educational Objectives finalized for the undergraduate program in Civil Engineering are listed below; 1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals 2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems 3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process 4. To prepare the Learner for a successful career in Indian and Multinational Organisations In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner’s point of view are also included in the curriculum to support the philosophy of outcome-based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. K. Ukarande

Chairman, Board of Studies in Civil Engineering,

University of Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course ‘Surveying-I (CE-C 302)”, the oral examination will be conducted in conjunction with practical/s

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai
Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -V)

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Practs.**	**Tut.**	**Theory**	**Practs.**	**Tut.**	**Total**
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	**Subject Name**	**Examination Scheme**								
		Theory					**Term Work**	**Practs.**	**Oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (In Hrs.)**				
		Test 1	**Test 2**	**Avg**						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course ‘Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course ‘Business and Communication Ethics (CE-C 507)’ will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying	CE-DLO6061: Advanced Construction Equipment
CE-DLO5062: Advanced Concrete Technology	CE-DLO6062: Traffic Engineering and Management
CE-DLO5063: Building Services and Repairs	CE-DLO6063: Ground Improvement Techniques
CE-DLO5064: Advanced Structural Mechanics	CE-DLO6064: Advanced Structural Analysis

University of Mumbai

Scheme of Instructions and Examination

Fourth Year Engineering (Civil Engineering)

(With effect from 2019-2020)

(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	2	--	4	1	--	5
CE-C703	Water Resource Engineering -II	3	2	--	3	1	-	4
CE-DLO704X	Department Level Optional Course-III	3	2	--	3	1	--	4
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**14**	**--**	**17**	**7**	**--**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 706), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai

Scheme of Instructions and Examination

Fourth Year Engineering (Civil Engineering)

(With effect from 2019-2020)

(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	--	2	4	--	1	5
CE-C802	Construction Management	4	--	2	4	--	1	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	1	3	--	1	4
CE-C804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**14**	**5**	**15**	**7**	**3**	**25**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	25	--	--	100
CE-P 804	Project – Part II	--	--	--			50	--	50#	100
Total		**80**	**80**	**80**	**320**		**150**		**125**	**650**

# The oral examination for the Project- Part II (CE-P 806) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.
(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.
(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design CE-DLO7047: Applied Hydrology and Flood Control	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Design of Hydraulic Structures

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester-V

Semester V

Subject Code	Subject Name	Credits
CEC501	**Structural Analysis-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	**4**	1	-	**5**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

There are various types of components in civil engineering structures, which are subjected to different types of loading or combinations thereof. The knowledge gained in the courses such as Engineering Mechanics, Strength of Materials and Structural Analysis -I is extended in this course. The scope of the course is to evaluate the response in the form of shear forces, bending moments, axial forces, and displacement parameters in various statically indeterminate structures such as beams, rigid and pin jointed frames. The course involves the concept of the displacement and flexibility approach for analysing the indeterminate structures. The course also involves the analysis of the indeterminate structures using the concept of plastic analysis and approximate analysis.

Objectives

- To revise the various concepts involved in the analyses of the structures studied in the course Structural Analysis-I.
- To analyze the statically determinate structures with reference to the variation in the temperature.
- To understand the concept of static and kinematic indeterminacy (degrees of freedom) of the structures such as beams & rigid pin jointed frames.
- To understand the concepts/ broad methods, sub-methods involved in the analysis of indeterminate structures.
- To apply various methods for analyzing the indeterminate structures to evaluate the response of such structures in the form of bending moment, shear force, axial force etc.
- To study the analyses of frame by approximate method.

Detailed Syllabus

Module	Sub Modules/Contents		Periods
1.		**General**	04
		Types of structures occurring in practice, their classification. Stable and unstable structures, static and kinematic determinacy and indeterminacy of structure. Symmetric structures, symmetrical & anti-symmetrical loads, distinction between linear and non-linear behaviors of material and geometric non-linearity. Two hinged arches: Introduction, classification and structural behavior (no numerical).	
2.		**Deflection of statically determinate structures**	04
		Introduction to the concept of complimentary energy, absolute & relative deflection caused by loads, temperature changes settlement of supports, application to beams, pin jointed frames, rigid jointed frames.	
3.		**Analysis of indeterminate structures by Force Method**	14
	3.1	Application of the Clapeyron's Theorem of Three Moments. Castigliano's theorem of least work Fixed Beams	
	3.2	Flexibility coefficients and their use in formulation of compatibility equations. Application to propped cantilevers, fixed beams, continuous beam and rigid jointed frames.	
	3.3	Application of flexibility method to simple pin jointed frames including effect of lack of fit for members.	
4.		**Analysis of indeterminate structures by Displacement Methods**	18
	4.1	Direct stiffness method: Stiffness coefficients for prismatic members, their use for formulation of equilibrium equations. Application to indeterminate beams & simple rigid jointed frames with inclined member but having only one translation degree of freedom.	
	4.2	Slope deflection method: Development of slope deflection equation, their use for formulation of equilibrium equations. Application to indeterminate beams & simple	

		rigid jointed frames with inclined member but having only one translation degree of freedom including the effect of settlement of supports.	
	4.3	Moment distribution method: Stiffness factor, distribution factor, Application to indeterminate beams & simple rigid jointed frames, having only one translation degree of freedom including the effect of settlement of supports.	
	4.4	Kani's Method: Fundamental equation of Kani's Method, application to simple beams and frames with single storey having two bays	
5.	**Plastic analysis of Steel structures**		**06**
	5.1	Introduction to plastic analysis, Concept of plastic hinge, plastic moment carrying capacity, shape factor.	
	5.2	Determination of collapse load for single and multiple span beams.	
6.	**Approximate Method for Analysis of Building Frames**		**06**
	6.1	Approximate method for gravity loads: Substitute frame method and equivalent frames.	
	6.2	Approximate method for lateral loads: Portal and cantilever method.	
		Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Understand the behavior of various statically indeterminate structures subjected to static loads and variation in temperature.
- Analyze the structures using displacement parameters to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc. for beams, 2D portal frames with various loads and boundary conditions, which becomes the basis for structural design.
- Contrast between the concept of force and displacement methods of analysis of indeterminate structures. Also, the elastic curve in beams and frames under the action of loads.
- Understand the concept of plastic hinge, plastic moment carrying capacity, shape factor and collapse load for single and multiple span beams.
- Find out the approximate dimensions of beams and columns using the approximate method for giving the input in design software. The knowledge gained in this subject shall also be useful for

application in the structural design in later years and also useful in the civil engineering field for the analysis purpose.

- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG Programme subjects such as Advanced Structural Analysis and Advanced Structural Mechanics in which they will be dealing with the indeterminate structures.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the tutorials and assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.
At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and Analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work:

- Assignments: 20 marks
- Attendance: 5 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Basic Structural Analysis: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Structural analysis: A Matrix Approach, Pandit and Gupta, Tata McGraw Hill publications.
3. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
4. Analysis of Structures: Vol. I and II, Vazirani and Ratwani
5. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, I K International publishing house, Pvt. ltd.
6. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
7. Comprehensive structural analysis (Vol. I and II), Vaidyanathan R., Laxmi publications
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: Devdas Menon, Narosa Publishing House.
10. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
11. Fundamentals of Structural Analysis: Sujit Kumar Roy and Subrota Chakrabarty, S. Chand Publications.
12. Structural analysis: Mohandas and Bhargab Mohan, Prentice hall international
13. Structural analysis: T. S. Thandavmoorthy, Oxford University Press

Reference Books:

1. Structural Analysis: Hibbler, Pentice Hall International.
2. Structural Analysis: Chajes, ElBS London.
3. Theory of Structures: Timoshenko and Young, Tata McGraw Hill New Delhi.
4. Element of Structural Analysis: Norries and Wilbur, McGraw Hill.
5. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
6. Structural theorem and their application: B.G. Neal, Pergaman Press.
7. Structural Analysis: Kassimali, TWS Publications
8. Fundamentals of Structural analysis: K.M. Leet, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: Heish, Prentice Hall

Semester V

Subject Code	Subject Name	Credits
CEC502	Geotechnical Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	**25**	**150**

Rationale

All civil engineering structures rest on ground i.e. supported by soil and rock. Rock is rarely occurring and hence mostly the supporting medium is soil. Hence the stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basics of physical properties which are useful for determining the strength, compressibility, drainage etc. The soil mechanics is the basic tool for geotechnical engineering which is the specialized section of civil engineering. Soil is also used as construction material to make various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I

Objectives

- To study the types of soil and relationships involving the weight, volume and other parameters of soil.
- To study the index properties of soil which is measure of the engineering properties and classify the soil based on different classification systems.
- To study the properties of soil related to flow of water.
- To study the concept of total stress, neutral stress & effective stress in soil.
- To understand the load deformation concept through compaction process.
- To understand the techniques of soil exploration, assessing the subsoil conditions & engineering properties of various strata along with presentation of report.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction to Geotechnical Engineering, Basic Definitions & Relationships**		**07**
	1.1	Definitions: Rocks, Soil, origin & mode of formation and type of soil obtained, soil mechanics, rock mechanics, soil engineering, geotechnical engineering	
	1.2	Scope of soil engineering: Importance of field exploration and characterization	
	1.3	Cohesionless & cohesive soils	
	1.4	Soil as three-phase & two-phase system in terms of weight, volume, void ratio, porosity	
	1.5	Weight-volume relationship: water content, void ratio, porosity, degree of saturation, air voids, air content, different unit weights, specific gravity of solids, and mass, absolute specific gravity.	
	1.6	Relationship between: different unit weights with void ratio, degree of saturation, specific gravity; different unit weights with porosity, void ratio, water content; different unit weights with water content, unit weights air voids.	
	1.7	Mention different methods to find water content, specific gravity, unit weight of soil (Detailed description to be covered during practical)	
2.	**Plasticity Characteristics of soils**		**06**
	2.1	Plasticity of soil: Definition of plasticity of soil, reason of plasticity, consistency of soil, explanation about idea set by Atterberg in defining the three states of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.2	Definitions of shrinkage parameters; plasticity index, shrinkage index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soils. Use of consistency limits	
	2.3	Explanation about clay minerals e.g. montmorillonite, illite, and kaolinite; their formation and role in producing the plastic behavior in soil	

3.	**Classification of soils**		**06**
	3.1	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498, boundary classification	
	3.2	Mechanical sieve analysis: wet & dry sieve analysis, combined sieve & sedimentation analysis, Stokes's law, hydrometer method of analysis, relation between percent finer and hydrometer reading. Limitation of sedimentation analysis, particle size distribution curve/gradation curve and its use	
	3.3	Relative density	
4.	**Permeability of soils & seepage analysis**		**10**
	4.1	Introduction about ground water flow: water table, types of aquifers, types of soil water, explanation of surface tension with capillary rise in small diameter tubes, capillary rise in soils	
	4.2	Definition of hydraulic head, hydraulic gradient, Darcy's law, laminar flow through soil, validity of Darcy's law.	
	4.3	Definition of permeability of soil, numerical values for different types of soils, determination of coefficient of permeability of soil in lab using constant head and variable head methods. Determination of in-situ permeability with pumping out and pumping in test. Permeability from indirect methods e.g. empirical equation & from consolidation data	
	4.4	Permeability of stratified soil deposits	
	4.5	Definition of seepage and its importance for the study of analysis & design of hydraulic structures. Derivation of Laplace equation for two-dimensional flow, its analytical solution representation by stream & potential function; Graphical representation by flow net, definition of flow line, equipotential lines, flow channel, field, characteristics of flow net, use of flow net	
	4.6	Solution of Laplace equation by other methods e. g. numerical methods	
5.	**Effective stress principle**		**03**
	5.1	Definition of geostatic stresses, vertical stress/total stress, neutral stress/pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage	

		pressure on effective stress; quick sand condition.	
6.	**Compaction of soils & soil exploration**		**07**
	6.1	Theory of compaction, determination of Optimum Moisture Content (OMC) & Maximum Dry Density (MDD) in laboratory by conducting the light and heavy compaction test.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, relative compaction	
	6.3	Necessity of soil exploration, methods of investigation, methods of boring, types of soil samples, soil samples sampling, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometers tests: SPT, SCPT, and DCPT.	
	6.5	Representation of data with borehole logs.	
		Total	**39**

Contribution to Outcomes

With the completion of this course, the students will be able to:

- Understand the soil types, index and engineering properties and relationship between various unit weights & other parameters.
- Classify the soil with a view towards assessing the suitability of a given soil for use; either to use if to support a structure (e.g. embankment) or to construct a structure therein (e.g. foundation)
- Understand the use of geosynthetics in soil to improve soil properties.
- Evaluate the compaction characteristics in laboratory & field and hence interpret the results with compaction specifications.
- Interpret soil boring data for foundation design.
- Conduct laboratory experiments to collect, analyze, interpret and present the data

Theory Examination:

1. Question paper will comprise of **six** questions: each having 20 marks.
2. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining 5** questions will be based on all the modules of entire syllabus. For this module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.

4. There can be an internal choice in various sub-questions/questions in order to accommodate the questions on all the topics/sub-topics.
5. The students will have to attempt **any three** questions out of **remaining 5** questions.
6. **Total four** questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work consisting of the report of experiments performed in the laboratory and assignment.

List of Experiments/Practical: (At least 8 to be performed)

1. Determination of natural moisture content using oven drying method

Following other methods to find moisture content shall be explained briefly:

   a) Pycnometer method
   b) Sand bath method
   c) Alcohol method
   d) Torsional balance method
   e) Radio activity method
   f) Moisture meter

2. Specific gravity of soil grains by density bottle method or pycnometer method
3. Field density using core cutter method
4. Field density using sand replacement method
5. Field identification of fine grained soils
6. Grain size distribution by sieve analysis
7. Grain size distribution by hydrometer analysis
8. Determination of liquid & plastic limit
9. Determination of shrinkage limit
10. Liquid limit by cone penetrometer method
11. Permeability using constant head method
12. Permeability using falling head method
13. Compaction test, IS light compaction test/ Standard Proctor test
14. Compaction test, IS heavy compaction test/ Modified Proctor test
15. Relative density test

Term Work:

a) The term work shall be comprised of the neatly written report based on the experiments performed in the laboratory as well as assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each modules/ sub-module content thereof further.

b) One assignment should be given on Geosynthetics. The teacher is expected to deliver extra lectures on geosynthetics for the entire class, thereby conveying the importance of the same to the students. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Definition of geosynthetics, types of geosynthetics: geotextiles, geogrids, geo cells, geomembranes, geo composites; types of geotextiles: woven and non-woven etc.; physical properties: apparent opening size (AOS), specific gravity, mass per unit area, thickness; basic hydraulic properties: permittivity, transmissivity of geotextile
- Filter design criteria for graded soil & geotextile filters

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the term work, assignments, and experiment reports. The final certification acceptance of term work warrants the satisfactory and appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments : 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Soil Engineering in Theory and Practice; *Alam Singh*, CBS Publishers Distributors, New Delhi
2. Soil Mechanics and Foundation Engineering: *V. N. S. Murthy*; Saitech Publications
3. Soil Mechanics and Foundation Engineering: *K. R. Arora*; Standard Publishers and Distributors, New Delhi

4. Soil Mechanics and Foundations: *Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain*; Laxmi Publications, New Delhi
5. Geotechnical Engineering: *C. Venkat Ramaiah*; New Age International
6. Fundamentals of Soil Engineering; *D. W. Taylor*, John Wiley & Sons.
7. An Introduction to Geotechnical Engineering: *R. D. Holtz*, Prentice Hall, New Jersey
8. Soil Mechanics: *R. F. Craig*, Champion & Hall
9. Soil Mechanics: *T. W. Lambe, R. V. Whitman*, John Wiley & Sons.
10. Designing with Geosynthetics: *R. M. Koerner*, Prentice Hall, New Jersey.
11. An Introduction to soil reinforcement geosynthetics: *G. L. Sivakumar Babu*, Universities Press.
12. Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC503	**Applied Hydraulics**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	**150**

Rationale

The knowledge of this course is essential to understand facts, concepts and design parameters of dynamics of fluid flow, application of momentum equation in lawn sprinklers and pipe bends, dimensional analysis and impact of jets. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines and design of open channels and flow through open channels.

Objectives

- To introduce the concept of dynamics of fluid flow and dimensional analysis
- To study hydraulic machines like centrifugal pumps, reciprocating pumps and turbines.
- To study the mathematical techniques used in research work for design conducting model tests.
- To impart the dynamic behavior of the fluid flow analyzed by the Newton’s second law of motion.
- To understand the uniform and non-uniform flow through open channels.
- To study design of open channel and understand concept of surface profile with hydraulic jump.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
1.	**Dynamics of Fluid Flow**	04
	Momentum principle (applications: pipe bends), moment of momentum equation (applications: sprinkler).	

2.		**Dimensional Analysis:**	**05**
		Dimensional homogeneity, Buckingham's π theorem, Reyleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynold's model law, Froude's model law, scale effect in models.	
3.		**Impact of Jets:**	**07**
		Introduction, force exerted on stationary flat plate: held normal to jet, held inclined to jet, hinged plates, curved plate: Stationary and Moving, symmetrical and unsymmetrical (Jet striking at Centre and jet striking tangentially at one end).	
4.		**Hydraulic Turbines:**	**11**
		General layout of hydro-electric plant, heads, efficiencies of turbine, classification, working of Pelton Wheel Turbine, Reaction Turbine, Francis Turbine, Kaplan Turbine and draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.	
5.		**Centrifugal pumps:**	**03**
		Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, specific speed, model testing, priming, characteristic curves, cavitations. Brief introduction to reciprocating pump.	
6.		**Flow through open channels**	**09**
	6.1	Uniform Flow: Flow through open channel: Definition, types of channels, Types of flows in channels, Prismatic, non-prismatic channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-section (most economical section).	
	6.2	Non-Uniform Flow: Specific energy and specific energy curve, Specific force, Hydraulic jump and standing wave. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles.	
		Total	**39**

Contribution to Outcomes

On completion of this course the student will be able to:

- Apply the concepts of fluid dynamics to solve pipe bend and sprinkler problems.
- Analyze dimensional problems and explain model laws.
- Explain the working and functions of Francis, Kaplan and Pelton wheel turbines.
- Explain the basic concepts of open channel hydraulics and measure discharge through open channels.
- Identify the occurrence of hydraulic jump and its parameters
- Explain uniform flow, non-uniform flow and establish mathematical relationships.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions **out of remaining five** questions.
5. **Total four** questions need to be attempted.

Oral Examination:

The oral examinations shall be based on the entire syllabus, the report of the experiments conducted by the students including assignments.

List of Experiments (Any six):

1. Impact of jet on flat plate/inclined plate/curved plate.
2. Performance of Pelton wheel- full gate opening.
3. Performance of Centrifugal pumps.
4. Performance of Kaplan turbine.
5. Performance of Francis turbine.
6. Determination of Chezy's roughness factor.
7. Study of gradually varied flow.

8. Study of hydraulic jump and its characteristics.
9. Calibration of Venturi-flume/Standing wave flume.

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr. P.N. Modi* and *Dr. S.M. Seth*, Standard Book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company, New Delhi.
3. Fluid Mechanics: *A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and Hydraulics: *S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
5. Fluid Mechanics and Fluid Pressure Engineering*:* *D.S. Kumar, F.K. Kataria* and sons 6. Fluid Mechanics: *R.K. Bansal*, Laxmi Publications (P) Ltd.
6. Flow in Open Channels: *K. Subramanya*; Tata Mc-Graw Hill Publishing House Pvt. Ltd.
7. Irrigation and Water Power Engineering: *B. C. Purnnia*.; Standard Publishers, New Delhi.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications: *R.L. Daugherty, J.B. Franzini, E.J. Finnemore,* Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: James F. Cruise, *Vijay P.Singh and Mohsen M. Sherif*, CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: *Edward J. Shaughnessy, Ira M. Katz, James P. Schaffer.* Oxford Higher Education.

Semester V

Subject Code	Subject Name	Credits
CEC504	**Environmental Engineering-I**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	**25**	**-**	**25**	**150**

Rationale

Environmental engineering is important for all human endeavours not simply about construction within the environment. This course lays emphasis on the practical application of knowledge, while at the same time recognizing the importance of theoretical knowledge in developing the intellectual capacity of the engineer. Knowledge of this course is useful for planning, designing, execution monitoring water supply sanitary schemes for the towns/cities. The scope of the course is to also solve the issues related to air and noise pollution.

Objectives

- To prepare students who can accomplish planning, design and construction of water systems and related infrastructural facilities.
- To provide the necessary knowledge on quality of water, concepts in the field of water supply and treatment.
- To impart necessary skill for the design and operation of water treatment plants.
- To introduce new developments in the field of water treatment and to inculcate the students with sound theoretical knowledge in engineering sciences as well as in research consultancy skills.
- To give a practical oriented knowledge so that they can give the practical solutions to environmental problems in the society and also to provide basic understanding of air pollution and monitoring.
- To impart positive responsive vocational attitudes, initiative creative thinking in their mission as an Engineers. Also provide the basic understanding of noise pollution.

Detailed Syllabus

Module		Sub Modules / Contents	Periods
1		**Water Supply and Distribution of Water**	03
		Water resources, Water supply systems, distribution systems of water, types of intake structure, water demand.	
2		**Quality of Water**	04
		Wholesomeness and palatability, physical, chemical, Biological standards, Treatment of water, drinking water standards, environmental chemistry, Eutrophication, Primary, Secondary and Tertiary treatment of water. Typical water treatment flow diagram.	
3	3.1	**Aeration and Sedimentation**	04
		Aeration, Types of Aeration systems, Theory and factors affecting efficiency of sedimentation, design of sedimentation tank and tube settlers.	
	3.2	**Coagulation and flocculation**	06
		Mechanisms, common coagulations, rapid mixing and flocculating devices, Jar test, coagulant aids – PAC.	
	3.3	**Filtration**	05
		Classification, slow and rapid sand filters, dual media filters, under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, head loss in filters and numerical on head loss, pressure filters: construction and operation.	
	3.4	**Water Softening**	02
		Lime soda and base exchange methods, Principle reactions, design considerations, sludge disposal.	
	3.5	**Disinfection**	03
		Chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, super chlorination, de-chlorination, chlorine residual, uses of iodine, ozone, ultra violet rays and chlorine dioxide as disinfectants, well water disinfection	

	3.6	**Advanced and Miscellaneous Treatments**	03
		Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese, taste, odour and colour, principles and methods, de-fluoridation.	
4	4.1	**Building Water supply**	02
		Introduction – Per Capita Supply, Determination of storage capacity, Service connection from main, water meter.	
	4.2	**Sanitary Fixtures**	
		Sanitary Fixtures and fittings: Introduction, classification of fixtures, soil fixtures, bathroom accessories, special accessories, fittings	
5		**Rainwater Harvesting**	02
		Need for rainwater harvesting, Annual potential, Collection of rain water for direct use or ground water recharge, Roof-top rain water harvesting	
6	6.1	**Air Pollution**	03
		Air-Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution-automobile pollution, Air quality standards, Control measures for Air pollution, construction and limitations	
	6.2	**Noise**	02
		Basic concept, measurement and various control methods. Thermal pollution.	

Contribution to Outcomes

After completion of the course the student will be able to:

- Understand the water supply system, its components and water demand by various consumers.
- Understand and analyze the quality of water and will be able to conduct the quality control test on samples.
- Understand the different processes in the water treatment facility.
- Design the different units of treatment for water treatment plants.
- Understand the components of building water supply system, storage and rain water harvesting.

- Understand the problems of air and noise pollution. Besides, they will be prepared to contribute practical solutions to environmental problems in our society.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and it will consist of short questions will have weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted.

List of Practical: (Any eight to be performed)

1. Determination of pH of water.
2. Determination of Alkalinity of water.
3. Determination of Hardness of water.
4. Determination of Turbidity of water.
5. Determination of Optimum dose of coagulant by using Jar Test Apparatus.
6. Determination of Dissolved Oxygen of Water.
7. Determination of Residual chlorine in water.
8. Determination of chlorides in water.
9. Most Probable Number.
10. High Volume Sampler.
11. Determination of Level Equivalent of Noise.

Site Visit:

The students should visit the Water Treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

Mini Project: (Any one)

A mini project shall comprise of

1. Design a basic plumbing system for water supply for residential/commercial building.

2. A case study for any existing structure.
3. Model making.
4. Software based design of water distribution system.

Term Work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory and Mini Project report. A detailed report on the visit to water treatment plant will also be submitted as a part of the term work.

Oral Examination:

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the site visit and the minimum passing marks to be obtained by the student.

The following weightage of marks shall be given for different components of the term work.

- Assignments & Experiments: 05 Marks
- Internal Oral examination based on Experiments and Assignments: 05Marks
- Mini Project: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:
75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi.
2. Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi
3. Plumbing Engineering Theory and Practice: S.M. Patil, Seema Publication, Mumbai.
4. Water Supply and Sewage: E.W. Steel, McGraw Hill, New York.
5. Water Supply and Sewage: T.J. McGhee, McGraw Hill, New York.

6. CPHEEO Manual on Water Supply and Treatment.
7. Water Supply Engineering: P.N. Modi, Rajsons Publication.
8. Water Supply Engineering: S. K. Garg, Khanna Publication.
9. Environmental Engineering (Vol. II)- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publication
10. Introduction to Environmental Engineering: Vesilind, PWS Publishing company.
11. Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.
12. Relevant Indian standard specifications.
13. Environmental Pollution: Gilbert Masters.
14. Basic Environmental Engineering: J.A. Nathanson, Prentice Hall of India.
15. Environmental Engineering: Sincero And Sincero.
16. Air pollution: *M. N Rao.,* Tata Mc Graw Hill, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC505	Transportation Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Transportation contributes to the economical, industrial, social and cultural development of any country. The adequacy of transportation system of a country indicates its economic and social development. Three basic modes of transportation include land, water and air. The land mode further gives rise to highways and railways. The highways owing to its flexibility in catering door-to- door service forms one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways for urban and rural areas. This course also deals with the planning, operation and control of the traffic.

Objectives

- To give insight of the development in the field of highway engineering, right from inception up to construction and maintenance and to familiarize the students with different surveys required to be carried out for the implementation of the highway project.
- To enable the students to understand the phase of engineering which deals with the planning and geometrics design of streets, highways, abutting land and with traffic operations thereon w.r.t. safe, convenient and economic transportation of people and goods.
- To enable the students to understand the properties of the different materials to be used in the construction of highways and other allied structures, characterize the materials and evaluate their suitability;
- To understand the principle of soil stabilization along with its significance and different types of stabilization techniques; and also, to study the concept of reinforced soil in the construction of highway and allied structures.

- To enable the students to understand the classification and behaviour of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements using various design methodologies
- To study the various methods of construction of different types of pavements including semi-rigid pavements and composite pavements, to study the different types of distresses in pavements, evaluation of existing pavements and methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Highway Planning and Development/ Highway Alignment and Surveys**		**03**
	1.1	Classification of roads based on the different criteria; brief history of road developments in India; present status of roads development programme in India, including different programmes being executed by various agencies.	
	1.2	Highway alignment, basic requirement of ideal alignment, factors governing highway alignment.	
	1.3	Different types of surveys for Highway location survey, map study, reconnaissance, topographic surveys, highway alignment in hilly area, drawing report preparation.	
2.	**Geometric Design of Highway**		**07**
	2.1	Terrain classification, vehicular characteristics, highway cross section elements, salient dimensions, clearances, width of carriage way, shoulders, medians, width of road way, right of way, camber along with its profile (IRC Standards).	
	2.2	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.3	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.4	Gradients: Different types of gradients (maximum, minimum, ruling, exceptional) grade compensation in curves, vertical curves: design factors, comfort sight distance, summit curve, valley curve.	

3.	**Traffic Engineering**		**05**
	3.1	Different Traffic Studies: Speed Studies (Spot Speed, Speed and Delay Studies), Traffic Volume, Parking Studies, Significance/ applications of these studies; different methods of conducting traffic studies, Methods of the presentation of data.	
	3.2	Introduction to relationship between Speed, density and volume; Capacity: Different types and factors affecting the capacity, concept of Passenger Car Units (PCU) and Level of Service (LoS).	
	3.3	Introduction to different types of Traffic Control Devices: Traffic signs, signals (no design), road marking.	
	3.4	Different types of intersections: At grade and grade separated; grade separated interchanges; rotary intersections.	
4.	**Highway Materials**		**06**
	4.1	Subgrade materials: desirable properties, modulus of elasticity, modulus of subgrade reaction, classification of subgrade soils, different strengths, various tests to be conducted to evaluate the suitability of the soil as the highway material.	
	4.2	Sub-base material: desirable properties, different tests to be conducted on aggregate, requirement of aggregate for different types of pavements.	
	4.3	Bituminous materials: types of bituminous material, test on bituminous material, desirable properties, grade of bitumen.	
	4.4	Soil Stabilization: Significance; principle of soil stabilization; different methods of soil stabilization, use of Geosynthetics in highways and allied structures.	
5	**Highway Pavement Design**		**09**
	5.1	Types of pavements: Flexible, Rigid, Semi-Rigid and composite; comparison between them vis-à-vis based on the structural behavior and other parameters; Factors affecting design of pavements including traffic factors (Design wheel load, equivalent single wheel load, equivalent wheel load factor/VDF)	
	5.2	Flexible pavement: Various approaches of designing the pavement and methods falling under each category (theoretical, semi-theoretical or	

		semi-empirical, empirical, mechanistic empirical and methods based on road performance); Overview of the method prescribed by IRC along with the modifications incorporated therein time to time (IRC: 37- 1970, 1984, 2001 and 2012); Design of the pavement using IRC: 37- 2001 and IRC: 37- 2012 with a more emphasis on latest IRC Code); Introduction to the design of low volume flexible pavement (IRC: SP 72- 2007/2015 and IRC: 77-2008).	
	5.3	Rigid Pavements: Introduction to the different types of rigid pavements (plain jointed, plain jointed reinforce, continuous reinforced, fiber reinforced, roller compacted concrete); Analysis of the stresses to be developed in the pavement (wheel load, warping and frictional); critical combination of the loading; Overview of the various approaches (Analytical, Empirical and Mechanistic empirical) of designing the pavements and methods falling under the respective category; overview of the methods prescribed by IRC along with modifications incorporated therein time to time (IRC: 58-1974, 58-1988; 58-2002 and 58-2015); Design of plain jointed rigid pavements (IRC: 58- 2002 and IRC: 58- IRC: 58- 2015 with more emphasis on IRC: 58-2015) including design of joints; Introduction to the design of low volume rigid pavement using (IRC: SP- 62-2004 and IRC: SP- 62-2014)	
6.	**Highway Construction/ Drainage/ Rehabilitation and maintenance**		**09**
	6.1	Construction of different types of roads: Introduction to the water bound macadam (WBM), wet mix macadam (WMM), bituminous pavements, plain jointed cement concrete pavements and along with various joints (as per IRC/ MORTH specifications), jointed reinforced, continuously reinforced; fiber reinforced, roller compacted concrete pavements.	

	6.2	Pavement failure: Classification of distresses in pavements (functional and structural); different types of distresses in flexible and rigid pavements along with the causes and remedial measures; various types of maintenance pavements; evaluation of pavements: functional and non-destructive evaluation of pavement, various equipment used in evaluation of pavements along with their principles (Profilometer, bump integrator, Benkelman beam, lacroixdeflectograph, falling weight deflectometer) and utility in the evaluation.	
	6.3	Strengthening of existing pavement: Objective of strengthening, different types of overlay, design of flexible overlays on flexible pavement using effective thickness approach, and deflection approach resorting to Benkelman Beam method (IRC: 81-1981) and Mechanistic Empirical approach using deflection (IRC: 81-1997); Introduction to the design of other types of overlays.	
	6.4	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage- surface and subsurface drainage inkling for the roads in hilly areas.	

Contribution to the Outcomes

On successful completion of the course, the students shall be able:

- To get an insight of the development in all the fields of highway engineering and familiarized with different surveys required to be carried out for the implementation of the highway project; to understand the phase of engineering which deals with the planning and geometrics design of streets, highways and abutting land in the context of safe and convenient traffic operations thereon.
- To know the required properties of the different materials to be used in the construction of highways and other allied structures, to understand characterization of the materials and to evaluate their suitability; understand the principle of soil stabilization, utilization of geosynthetics in the construction of highway and allied structures
- To understand the classification of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements and can the flexible and rigid pavements be using IRC Specifications.

- To get an insight into the methods of construction of different types of pavements; along with the importance of highway drainage and various methods of providing the drainage; also, to understand the elements of bridge engineering.
- To illustrate different distresses in the pavements, evaluate the pavements in terms of its functional and structural adequacy and arrive upon the rehabilitation measures.
- To explain methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. There can be **an internal choice** either in the main question or sub-question to accommodate the contents of all the modules.
5. The students will have to attempt **any three** questions **out** of **remaining five** questions.
6. **Total four** questions need to be attempted.

Oral Examination:

The oral examinations shall be based on the entire syllabus the report of the experiments conducted by the students including assignments and the Traffic Survey Report.

List of Practical:

Although it is recommended that 12 experiments are desirable, at least nine should be performed.

1. Impact test on aggregates
2. Abrasion test on aggregates
3. Crushing test on aggregates
4. Shape test on aggregates
5. Soundness test
6. Polished stone value test

7. Stripping value or bitumen adhesion test (water sensitivity)
8. Penetration test on bitumen
9. Ductility test on bitumen
10. Softening point test on bitumen
11. Viscosity test on bitumen
12. Flash point and fire point test on bitumen
13. Marshall stability test on the bituminous mix
14. CBR test on subgrade soil material (Laboratory or Field)
15. Plate bearing test on subgrade soil

Term Work:

The term-work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. There shall be at least 10 assignments which will comprise of numerical problems and lay-out sketches, covering the entire syllabus divided properly module wise. In addition to this, the students shall conduct any one of the traffic surveys and will prepare a detail report thereof. This report shall also form a component part of the term work.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Traffic Study Report: 04 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%-80%: 03, Marks: 81%-90%: 04, Marks: 91% onwards: 05 Marks.

Recommended Books:

1. Highway Engineering: *Khanna, S.K., Justo, C. E. G. and Veeraraghavan A*; NemChand and Bros., Roorkee (Revised 10th Edition)
2. Principles and Practice of Highway Engineering: *Kadiyali, L. R.*; Khanna Publishers, Delhi
3. A Text Book of Highway and Traffic Engineering: *Saxena, Subhash Chandra*; CBS Publishers and Distributors (2014)

4. A Text Book of Highway Engineering: *Sriniwasakumar, R.*; University Press, Hyderabad (First Published in 2011; Reprinted in 2013)
5. Transportation Engineering (Vol.-I)- Highway Engineering: *Venkatramaiah, C.*; University Press, Hyderabad (2016).
6. Principles of Transportation and Highway Engineering, *Rao, G.V.;* Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
7. Principles, Practice and Design of Highway Engineering (Including Airport Engineering): *Sharma, S.K.;* S. Chand and Company Pvt. Ltd., New Delhi.
8. Principles of Transportation Engineering: *Chakraborty, Partha and Das, Animesh*; Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

Reference Books:

1. Transportation Engineering and Planning: *Papacostas, C.S. and Prevedouros, P.D.*; Prentice Hall India Learning Pvt. Ltd., New Delhi.
2. Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.;* Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Traffic Engineering and Transport Planning: *Kadiyali, L.R.*, Khanna Publishers, Delhi
4. Pavement Design: *Srinivasakumar, R*; University press, Hyderabad (First Published 2013; Reprinted in 2015).
5. Highway Material and Pavement Testing*: Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.;*Nem Chand and Bros., Roorkee, India.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Planning related aspects in the context of Highway Geometrics/ Traffic Planning/ Pavement Design and Highway Construction)

Note: Some of the recent specifications may not have been incorporated in few books. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes shall be referred to.

Semester V

Subject Code	Subject Name	Credits
CE-DLO5061	Department Level Optional Course – I: Advanced Surveying	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

This is an advanced course which is intended to teach students about applications of modern surveying instruments with their principle and uses in surveying for different civil engineering works. Student should get exposed to the concept of Total Station, G.P.S., G.I.S. and Remote Sensing techniques. To make the students acquainted with the field problems, various groups of students not less than 2 and more than 4 should be formed, and they will research on use of various Geospatial tools for tackling problems based on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.

Objectives

On completion of the course, the student will be able to:

- Use Total Station & GPS for desired requirements in surveying.
- Establish surveying control to determine required accuracy using Total Station, GPS, GIS and remote sensing.
- Stake out the designed data by using modern high precision surveying instruments.
- Generate and utilize field surveying data and incorporate design data using specialized software.
- Critically evaluate the use of advance positioning instrument for surveying and setting out.
- Apply GIS for solving civil engineering problems.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Modern Surveying Equipment**		3
	1.1	Introduction.	
	1.2	Electronic Distance Measuring Instrument (EDMI), Use of lasers in Surveying	
	1.3	Electronic Theodolite, Total Station and Scan Station	
2	**Global Positioning System**		**8**
	2.1	Basics of GPS, Positioning using satellites, GPS principles, GPS receivers, GPS principles	
	2.2	GPS errors and accuracy Error sources in GPS observations Satellite geometry and accuracy measures	
	2.3	GPS measurements techniques, GPS algorithms/Navigational solutions Other satellite navigation systems and GPS modernization	
	2.4	Civil engineering application of GPS	
3	**Photogrammetry**		**6**
	3.1	Introduction to geometry of vertical photographs Geometry of tilted photographs, photogrammetric terms; Applications; Type of photographs; perspective geometry of vertical and tilted photographs, heights and tilt distortions;	
	3.2	Flight planning; Stereoscopy, base lining, floating marks, parallax equation and stereo measurements for height determination, Developments in photogrammetry: analogue, analytical and digital methods, photogrammetric instruments.	
	3.3	Civil engineering application of photogrammetry	
4	**Remote Sensing**		**10**
	4.1	Introduction: Physical basis of remote sensing- Electro-magnetic radiation (EMR)-nature, nomenclature and radiation laws; Interaction in atmospheric nature, its effects in various wavelength regions, atmospheric windows;	

		interaction at ground surface- soils and rocks, vegetation, water, etc.; Physical basis of remote sensing (Radiometry)	
	4.2	Geometric basis of interaction, Platform and sensors, Terrestrial, aerial and space platforms; Orbital characteristics of space platforms, sun and geo-synchronous; Sensor systems radiometers, optomechanical and push broom sensor; Resolution- spectral, spatial, radiometric and temporal; Data products from various air and spaceborne sensors- aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS, etc. Image interpretation- Elements of interpretation; Manual and digital interpretation; Field verification	
	4.3	Remote sensing: Image Interpretation, Introduction to image processing techniques, Image enhancement, Information extraction	
	4.4	Civil engineering application of Remote Sensing	
5	**Geographical Information System**		**8**
	5.1	Introduction to GIS, its hardware and software components Geographical data in computer: Data structures for GIS, Components of GIS- data acquisition, spatial and attribute data, pre-processing, storage and management; Data structures- raster and vector data; GIS analysis functions; Errors and corrections; Data presentation and generation of thematic maps. Introduction to QGIS software	
	5.2	GIS manipulation, query running, analysis and modelling, Errors and corrections	
	5.3	Civil Engineering Application of GIS	
6	**Hydrographic Survey**		**4**
	6.1	Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders	
	6.2	Civil Engineering Application of Hydrographic Survey	

Contribution to Outcomes

On completion of the course, the students will be able to:

- Select appropriate methods and instruments in surveying, based on accuracy and precision required, sophistication, availability of resources, economics and duration of project.
- Appreciate the superiority and leverage of using modern methods in surveying over conventional ones.
- Employ modern surveying methods, for solving complex surveying problems
- Apply different advance surveying methodologies to carry out large scale survey works as modern instruments have largely changed the approach to survey works with the principles being same.
- Collect and manipulate data using GIS for simplifying data management and also reducing labour.
- The knowledge of limits of accuracy will be obtained by making measurements with various surveying equipment employed in practice.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.

2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. The students will have to attempt **any three** questions out of remaining five questions.

5. Total **four** questions need to be solved.

Oral Examination:

The oral examination shall be based on the entire syllabus, the projects performed and practical conducted. It will include a practical exam (10 marks), before proceeding for viva (15 marks)

List of Practical:

1. Determination of co-ordinates of profile by GPS and length of profile.
2. Profile Leveling (Open Traverse) by Total Station and print output by using any software interface
3. Navigation of existing co-ordinates by GPS
4. Digitization work by any GIS software, like QGIS, ArcGIS, Gram++, etc.
5. Setting out a foundation plan of RC structure in the field using Total Station.

6. Mini Project on GIS using various software

Term work: It shall consist of the following:

1. **Mini Project** forming a group not less than 2 and more than 4 based on use of Geospatial tools for tackling problems on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.
2. Presentation on any one modern tool
3. Practical write up, clearly stating aims, objectives, sketches, observations, results and subsequent discussion of results
4. The assignments shall comprise at least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Mini-project: 05 Marks
- Report of the Experiments: 05 Marks
- Assignments: 05 Marks
- Presentation: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Study Materials

(A) Recommended Books:

1. Higher surveying: *A.M. Chandra*, New Age International publishers.

2. Higher surveying: *B.C. Punimia, Ashok Join, Arun K. Jain,* Laxmi Publications(P), Ltd.

3. Geographic Information System and Science: *Longley, Paul A., Michael F. Goodchild, David J. Maguuire, David W. Rhind*, John Wiley and Sons, New York (2nd Ed.), 2005

4. Modeling Our World: The ESRI Guide to Geodata base Design: *Zeiler, M*. ESRI Press, Redlands, California, 1999.

5. GIS, Spatial Analysis, and Modeling: Maguire, *D., M. Batty, and M. Goodchild* 2005. ESRI Press (070.212.05842005)

6. Global Positioning System: Signals, Measurements, and Performance, *Pratap Misra and Per Enge*(2nd Ed.), 2006.

7. Remote Sensing Principles and Interpretation*: Floyd, F. Sabins, Jr:, Freeman* and Co., San Franscisco,1978.

8. A Remote Sensing Perspective: Introductory Digital Image Processing: *John, R. Jensen*, Prentice Hall.

9. Imaging Radar for Resource Survey: Remote Sensing Applications: *W. Travelt*, Chapman and Hall.

10. Remote Sensing and GIS, *B Bhatia*, Oxford University Press, New Delhi.

11. Remote sensing and Image interpretation, *T.M Lilles, R.W Kiefer and J.W Chipman*, 5th edition, John Wiley and Sons India

12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. & Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002

13.Remote Sensing and Geographical Information Systems, *M. Anji Reddy*, B.S. Publications, Hyderabad, 2001

(B) Web Materials:

1. http://nptel.ac.in/courses/105104100/1
2. http://www.surveyofindia.gov.in/
3. http://www.iism.nic.in/
4. http://bhuvan.nrsc.gov.in/bhuvan_links.php
5. http://igrmaharashtra.gov.in/#

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5062	Department Level Optional Course-I: Advanced Concrete Technology	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. The concrete technology is the backbone of infrastructure of civil engineering field. The students must know various concreting operations and testing operations during and after construction. It is expected to know the properties of materials, especially concrete and to maintain quality in construction projects. The civil engineering students ought to know the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

This course mainly aims to develop the knowledge about properties/ design and testing of advanced cement concrete.

Expected Outcome: Upon completion of this course, the student will be able to

- Know the various materials and properties in concrete.
- Understand the various properties of special concrete
- Understand the Mix design by different methods.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability and cracking in concrete.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Properties of Concrete:**		5
	1.1	Cement and its types: general, hydration of cement, water requirement for hydration, alkali aggregate reaction. Aggregate: grading curves of aggregates.	
	1.2	Concrete: properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, curing and its method.	
2.	**Special Concrete:**		5
	Light weight concrete, ultra-light weight concrete, vacuum concrete, mass concrete, waste material-based concrete, shotcreting, guniting, sulphur concrete and sulphur infiltrated concrete, jet cement concrete (ultra-rapid hardening), gap graded concrete, no fines concrete, high strength concrete, high performance concrete.		
3.	**Concrete Mix Design:**		9
	3.1	Design of concrete mixes by IS code method - ACI method - Road Note No: 4 methods.	
	3.2	Design of high strength concrete mixes, design of light weight aggregate concrete mixes, design of fly-ash cement concrete mixes, design of high density concrete mixes.	
4.	**Fibre Reinforced Concrete:**		6
	Historical development of fibre reinforced concrete, properties of metallic fibre, polymeric fibres, carbon fibres, glass fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), basic concepts and mechanical properties: tension and bending.		
5.	**Testing of Concrete:**		8
	5.1	Properties of hardened FRC, behaviors under compression, tension and flexure of steel fibres and polymeric fibres.	

	5.2	Advanced non-destructive testing methods: ground penetration radar, probe penetration, pull out test, break off maturity method, stress wave propagation method, electrical/ magnetic methods, nuclear methods and infrared thermography, core test.	
6.	**Durability of Concrete:**		**6**
	Durability, Transport mechanism of fluids and gases in concrete, cracking in concrete - corrosion and carbonation induced cracking, Alkali Aggregate Reaction, degradation by freeze and thaw, chloride attack, sulphate and sea water attack (marine conditions). Hot and cold weather concreting.		
		Total	**39**

Contribution to Outcomes

On completion of the course, the students shall be able to:

- Know the various materials and properties in concrete.
- Understand the Mix design by different methods.
- Understand the various properties of special concrete.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability of concrete.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions out of remaining five questions.
5. Total **four** questions need to be attempted

Oral Examination:

The oral examination shall be based on the entire syllabus and experiments performed in the laboratory.

List of Practical (Any Eight to be performed):

1. Mix design in laboratory by ACI Method.
2. Mix design in laboratory by Road Note 4.
3. Chemical Admixture (Superplasticiser) optimization by Mini Slump and Marsh cone.
4. Concrete- Slump, Slump retention by Slump cone.
5. Split and Modulus of rupture of concrete.
6. Permeability test on concrete.
7. Rapid chloride penetration test
8. Tests on polymer modified concrete/mortar.
9. Tests on fiber-reinforced concrete.
10. Nondestructive testing of concrete- some applications (hammer, ultrasonic etc.).
11. Carbonation test on concrete.
12. Pull out/ pull off test on concrete.

Term Work: It shall consist of the following:

1. Neatly written report of afore mentioned experiments (at least eight)
2. Presentation on any emerging trend in concrete technology.
3. At least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 05 Marks
- Presentation: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Study Materials

(A) Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Relevant I.S. codes: Bureau of Indian standard.
5. Special Publication of ACI on Polymer concrete and FRC.
6. Proceedings of International Conferences on Polymer Concrete and FRC.
7. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
8. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
9. Chemistry of Cement and Concrete: F.M. Lue, Edward Arnold, 3rd Edition, 1970.
10. Concrete Technology: D.F. Orchardi, Wiley, 1962.
11. Tentative Guidelines for cement concrete mix design for pavements (IRC: 44-1976): Indian Road Congress, New Delhi.
12. Concrete mix proportioning-guidelines (IS 10262:2009).
13. Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999.
14. Concrete Mixture Proportioning- A Scientific Approach: De Larrard F., E&FN Spon, London, 1999.
15. Fibre Reinforced Cementitious Composites: ArnonBentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.

(B) Web Materials:

1. www.theconcreteportal.com
2. www.concrete.org

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5063	Department Level Optional Course-I: Building Services & Repairs	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Building service systems are complex. They are typically a major source of cost & potential coordination problems in building construction. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professional. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in building construction for an existing building to be in a good condition, so that it can continue to perform the intended functions, maintenance of the building plays a key role. Adequate maintenance improves aesthetic &functional values. Moreover; it facilitates extending the building life & ensures the safety of dwellers. Usually, the structures do perform well for about 50 years after the construction & thereafter, the deterioration begins. Insufficient maintenance & lack of repairs may lead to the limited life span of the structure. However, the regular maintenance & timely identification of deteriorated building elements for proper remedial measures may result in to the extension of life span of the structure up to 100 years also. The course deals with the building maintenance, special materials, concrete repair chemicals, strengthening of RCC members by underpinning, plate bonding, shoring, RC jacketing, etc. Technical knowhow and skills developed through this course may be helpful to preserve the historical buildings. Fire safety is to be studied in order to safeguard the building from fire damage.

Objectives

- To understand the concepts of building services & its applications.
- To understand design concepts of various machineries like lift, escalators, vibrators, concrete mixers, etc. & utility services in building like plumbing system, electrical system, etc.

- To get familiar with the causes of distress of concrete structures, seepage & leakage in concrete structures & the effect on steel corrosion.
- To study the condition survey, evaluation and assessment of damage through the visual inspection & various Non-Destructive Testing methods.
- To acquire the knowledge in connection with the special repair materials and crack repair methodologies to be applied in the field.
- To study the concrete protective materials, thermal protection coatings, etc. and implement the steel corrosion protection methods in the field.
- To study the fire safety of the structures.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Machineries**		05
	Lifts & Escalators- Special features required for physically handicapped & elderly, Conveyors, Vibrators, Concrete mixers, DC/AC motors, Generators, Laboratory services, Gas, Water, air & electricity, Hot water boilers and pumps		
2.	**Plumbing Systems & Fire safety in Building**		08
	2.1	Plumbing Services: Water Distribution system, Material for service pipes, Service connection, Size of service pipe, Water meter, valves and storage tanks.	
	2.2	Drainage system: Pipe and traps, system of plumbing, House drainage plans, septic tanks and soak pit.	
	2.3	Fire Safety Installation: Causes of fire in building - safety regulation - NBC - Planning considerations in building like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. system. Special features required for physically handicapped and elderly in building types - Heat and smoke detectors - Fire alarm system, snorkel Ladder - Fire Lighting pump and water storage - Dry and wet riser - Automatic sprinklers	

3.	**Electrical systems & Illumination Design in Buildings**		**07**
	3.1	Electrical systems in buildings: Basics of electricity - Single / Three phase supply, Protective devices in electrical installations, earthing for safety, Types of Earthing, ISI specifications, Types of wires, wiring systems &their choice, Planning electrical wiring for building, Main &distribution boards, Transformers & switch gears, Layout of substations	
	3.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Modern theory of light &colour, Synthesis of Light, Additive & Subtractive synthesis of colour, Luminous flux, candela, solid angle illumination, utilization factor, Depreciation factor, MSCP, MHCP, Lens of illumination, Classification of lighting, Artificial lights sources, spectral energy distribution, Luminous efficiency, colour temperature, colour rendering.	
	3.3	Design of Modern lighting: Lighting for stores, offices, school, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
4.	**Deterioration of Concrete Structures**		**05**
	4.1	Causes of deterioration of concrete structures, effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design& construction errors.	
	4.2	Causes of seepage & leakage in concrete structures. Formation of cracks including those due to corrosion.	
5.	**Condition Survey, Evaluation & Damage Assessment**		**05**
	5.1	Diagnostic methods & analysis.	
	5.2	Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity test, and crack measurement techniques, Concrete endoscopy & thermal imaging, pull-off test & pull-out test.	
6.	**Materials & Repair Methodologies, Protection of Concrete Structures & Rebar Corrosion Protection**		**09**

	6.1	Repair analysis & design.	
	6.2	Repair materials and their desired properties.	
	6.3	Methodologies for crack and patch repair: polymer modified mortar, polymer modified concrete, polymer concrete	
	6.4	Injection grouting, shotcrete, joints and sealants, rebar corrosion crack repair 10.5	
	6.5	Protective materials and their properties for moisture barrier systems.	
	6.6	Above grade and below grade water-proofing of concrete structures.	
	6.7	Systems like integral, crystalline, coatings, membranes, etc.	
	6.8	Thermal protection coatings.	
	6.9	Methods of corrosion protection, corrosion inhibitors	
	6.10	Corrosion resistant steels, cathodic protection	
	6.11	Pre-packed zinc sacrificial anode, Snap-on zinc mesh anode CP system.	
		Total	**39**

Contribution to Outcomes

On successful completion of the course, it is expected that the course will enable the students to:

- Understand the importance & installation of utility services.
- Understand the drawbacks of all the service lines are not installed properly or if materials used are faulty.
- Choose appropriate systems & integrate the same into the building construction projects.
- Assess the structural health of the buildings & infrastructural works and also Inspect & evaluate the damaged structures.
- Implement the techniques for repairing the concrete structures and also decide whether or not the structure should be dismantled, if it is deteriorated beyond repair.
- Employ the methods of steel protection in the field.
- Understand the damage caused by fire & exercise due care for fire safety.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory.** It will have short questions, each carrying 4 to 5 marks, covering the entire syllabus.

3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents, thereof.
4. There can be options within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus & the term work consisting of the assignments& experiments.

List of Practicals:

1. Carbonation test by spraying phenolphthalein
2. Non -destructive testing of concrete structures by Rebound hammer.
3. Non -destructive testing of concrete structures by UPV meter.
4. Outdoor exposure test to measure weathering of coating
5. Test for flexibility of coating by applying on a tin sheet
6. Test for effectiveness by measuring water absorption of coating applied on a card board.

Condition Survey:

The students will carry out the condition survey of any damaged structure by visual observations& will prepare a detailed report thereof. This report will form a part of the term work.

Term Work:

The term-work shall comprise of the neatly written report based on the experiments/ practical performed & the assignments along with the detailed report on the condition survey.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon its quality. The final certification and acceptance of the term work warrants the satisfactory performance of the experiments/ practical by the student, properly compiled report thereof along with the assignments and the report on condition survey & the minimum passing marks to be obtained by the student. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ questions on each sub-modules & contents thereof further. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Report on the Condition Survey: 04 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks 81%- 90%: 04 Marks 91% onwards: 05 Marks.

Recommended Books:

1. Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968.
2. Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
3. Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4. The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
5. National Building Code.
6. Building Construction: *Dr. B. C. Punmia, Ashok K Jain*, A.K Jain
7. Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
8. Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi
9. Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication.
10. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
11. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
12. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf.
13. Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.
14. Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis Publication.
15. Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.

16. Testing of Concrete in Structures: *John H. Bungey*, *Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
17. Durability of concrete and Cement Composites: *Page, C.L.*and Page*, M.M.,* Woodhead Publishers
18. Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5064	Department Level Optional Course-I: **Advanced Structural Mechanics**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

- To understand the concept of shear centre& evaluate the shear centre for symmetrical & un-symmetrical thin walled sections.
- To understand the concept &behavior of beams resting on elastic foundation.
- To study the behavior of beams curved in plan.
- To understand the concept of different theories of failure in regards of materials.
- To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Shear centre:**		5
	Shear Centre for symmetrical & unsymmetrical (about both axes) thin walled open sections.		
2	**Bending of beams with large initial curvature:**		8
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	**Beams on elastic foundation:**		8
	3.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	3.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
4	**Beams curved in plan:**		5
	4.1	Analysis of beams loaded perpendicular to their own plane.	
	4.2	Simply supported, fixed & continuous beams.	
5	**Theories of Failure:**		7
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	**Analysis of deep beams:**		6
	6.1	Determination of deflection	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
	6.3	Stress concentration, stress concentration factor.	
		Total	**39**

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

- Understand the concept of shear centre for thin walled open sections.
- Study the behavior of beam resting on elastic foundation with various loading conditions.
- Analyze the beam curved in plan for different support conditions.
- Understand the concept of different theories of failure in different sections.
- Determine deflection, shear correction factor for different sections like solid & hollow sections.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying **20** marks.
2. The **first** question will be **compulsory**, which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt **any three** questions out of **remaining five** questions.
6. Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report based on the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof further.

Oral Examination:

The oral examination shall be based upon the entire syllabus & the term work.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Mechanics of Materials: Popov, E.P. Prentice Hall of India Pvt. Ltd.
2. Mechanics of Materials: James Gere, M., Thomson Brooks.
3. Mechanics of Materials: Beer, F.P., E. Russell Jhonston and John T. DeWolf, TMH, New Delhi.
4. Advanced Mechanics of Materials: Arthur P. Boresi and Omar M. Sidebottom, Wiley and Sons.
5. Advanced Mechanics of Materials: Arthur P. Boresi and Richard Schmidt, John Wiley and sons.
6. Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
7. Mechanics of Solids: Shames, I and Pitarresi, J. M., Preentice Hall, New Delhi.
8. Beams on Elastic Foundation: Heteny M. 9. Strength of Materials: Subramanian, Oxford University Press.

Semester V

Subject Code	Subject Name	Credits
CE507	**Business and Communication Ethics**	**2**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	**4#**	-	**-**	**2**	-	2

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	50	-	-	50

Rationale

Ethical issues of **Business Communication** are the process by which individuals exchange information between other individuals or groups of people. Throughout the process, effective communicators try as clearly and accurately to convey their thoughts, intentions and, objectives to their receiver. This course is very important for aspiring Civil Engineers as the industry suffers major delays due to miscommunication between various parties to the contract.

Objectives

- To inculcate professional and ethical attitude.
- To enhance effective communication and interpersonal skills.
- To build multidisciplinary approach towards all life tasks.

Detailed Syllabus

Module	**Sub-Modules/ Contents**		**Periods**
1	**Report Writing**		**05**
	1.1	Objectives of Report Writing	
	1.2	Language and Style in a report	
	1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	

2	**Technical Writing**		**03**
	2.1	Technical Paper Writing (ASCE Format)	
	2.2	Proposal Writing	
3	**Introduction to Interpersonal Skills**		**09**
	3.1	Emotional Intelligence	
	3.2	Leadership and Motivation	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution and Negotiation Skills	
	3.6	Time Management	
	3.7	Decision Making	
4	**Meetings & Documentations**		**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice, Agenda and Minutes of a meeting	
	4.3	Business meeting etiquettes	
5	**Introduction to Corporate Ethics**		**02**
	5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
	5.2	Introduction to Intellectual Property Rights	
	5.3	Ethical codes of conduct in business and corporate activities(Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
6	**Employment Skills**		**07**
	6.1	Group Discussion	
	6.2	Resume Writing	
	6.3	Interview Skills	
	6.4	Presentation Skills	
	6.5	Statement of Purpose	
		Total	**28**

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Term Work:

The term-work shall comprise of the neatly written report based on the Assignments, Project Report Presentation and Group Discussion. The assignments shall be given according to the list given below

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate

completion of the assignments and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work. Term work will consist of all assignments from the list. The distribution of marks for term
Work will be as follows:

- Book Report: 10 Marks
- Assignments:10 Marks
- Project Report Presentation: 15 Marks
- Group Discussion:10 Marks
- Attendance:05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition
5. Heta Murphy*, "Effective Business Communication",* Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill.
8. Lehman, Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Semester VI

Semester VI

Subject Code	Subject Name	Credits
CEC601	**Geotechnical Engineering-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	**3**	1	-	**4**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	**-**	**25**	**150**

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers; and more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative business and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

- Students will gain knowledge of consolidation theory.
- Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.
- Students will analyze stability of slopes, comprehend lateral earth pressure theories and apply them in stability analysis of retaining walls.
- Students will analyze and design shallow as well as deep foundations.
- Students will gain knowledge of underground conduits and braced cuts.
- Students will gain knowledge of ground improvement techniques.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Consolidation of soils**		04
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion recompression indices, normally over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	**Shear strength**		05
	2.1	Introduction, three dimensional state of stress in soil mass, principal stresses in soil, shear failure in soils- frictional cohesive strength, general shear stress-strain curves in soil definition of failure, graphical method of determination of stresses on a plane inclined to the principal planes through Mohr's circle, important characteristics of Mohr‘s circle.	
	2.2	Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure criterion- relation between major minor principle stresses, total & effective stress analysis.	
	2.3	Different types of shear tests drainage conditions; Direct shear test, Triaxial compression test (UU, CU CD), Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves Mohr failure envelopes	
	2.4	Determination of shear strength of soil with geosynthetics- pull out test: ASTM procedure for finding shear strength of soil-geosynthetic system.	

3.	**Stability of Slopes**		**04**
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage along the slope	
	3.3	Stability analysis of finite slopes: i) Culmann’s method, ii) Swedish slip circle method, iii) friction circle method and iv) Taylor’s stability number	
4.	**Lateral Earth Pressure Theories and Stability of Retaining Walls**		**10**
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine’s earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb’s wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann’s Graphical Method (no proof)	
	4.5	Culmann’s Graphical Method (no proof)	
	4.6	Introduction to retaining walls: types of retaining walls, stability checks for retaining walls	
	4.7	Stability analysis of gravity retaining walls	
	4.8	Stability analysis of cantilever retaining walls	
5.	**Shallow Foundations**		**10**
	5.1	Introduction: types of shallow foundations, definitions of different bearing capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi’s theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi’s theory ii) Vesic’s theory: bearing capacity equation	

		iii) I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6.	**Pile Foundations**		**6**
	6.1	Introduction to pile foundations: types of pile foundations, necessity of pile foundations	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
		Total	**39**

Contribution to Outcomes

- Students will be able to evaluate the consolidation parameters for the soil.
- Students will be able to calculate the shear strength parameters for the soil.
- Students will be able to calculate the factors of safety of different types of slopes under various soil conditions, analyze the stability of slopes, calculate lateral earth pressures and analyse the stability of retaining walls.
- Students will be able to calculate bearing capacity of shallow foundations using theoretical and field methods, calculate load bearing capacity of individual as well as group of pile foundations and their settlement using theoretical and field methods
- Students will be able to explain conduits and calculate the load carried by the struts of a braced cut under various soil conditions.
- Students will be able to explain ground improvement techniques.

Theory Examination

1. Question paper will consist of total **6** questions; each carrying 20 marks.
2. Only **4** questions (out of 6) need to be attempted.
3. Question no. **1** will be **compulsory.**

4. Any **3** out of the remaining **5** questions need to be attempted.
5. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Oral Examination:

The oral examination shall be based upon the entire syllabus

Term Work:

Although it is recommended that 7 experiments are desirable, at least 5 should be performed.

1. Determination of pre-consolidation pressure coefficient of consolidation from one dimensional consolidation test.
2. Determination of shear parameters form unconsolidated undrained tri-axial compression test
3. Determination of shear parameters from direct shear test
4. Determination of cohesion from unconfined compression test
5. Determination of CBR value from CBR test
6. Determination of shear strength of soft clays from vane shear test.
7. Determination of swelling pressure of clays

Assignments:

a) Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on GROUND IMPROVEMENT TECHNIQUES. The teacher is expected to deliver extra lectures on the topic, thereby imparting the knowledge to the students, about the concept of ground improvement. The questions related to ground improvement techniques shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Reinforced earth: Design of reinforced earth wall
- Geotextiles: definition, types, functions and use in civil engineering

- Introduction to stone columns and prefabricated vertical drains

Distribution of Term Work Marks

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications
2. Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors
3. Soil Mechanics and Foundation Engineering: V. N. S. Murthy; Saitech Publications
4. Geotechnical Engineering: C. Venkatramaiah; New Age International
5. Soil Engineering in Theory and Practice: Alam Singh; CBS Publishers Distributors
6. Designing with Geosynthetics: R. M. Koerner; Prentice Hall, New Jersey
7. An Introduction to Soil Reinforcement Geosynthetics: G. L. Sivakumar Babu; Universities Press
8. Theoretical Soil Mechanics: K. Terzaghi; John Wiley and Sons
9. Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and Sons.
10. Relevant Indian Standard Specifications Code: BIS Publications, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC602	**Design and Drawing of Steel Structures**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	**4**	1	-	**5**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	25	---	$25^{@}$	150

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. IS code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

- To make students familiar with behavior of steel structure and their components under the action of various loads.
- To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
- To equip students with aspects required for designing tension member, compression members and column bases.
- To equip students with aspects required for designing beams and welded plate girder
- To help students design connections in steel members
- To aid students in designing steel trusses.

Detailed Syllabus

Module	Sub Modules/Contents		Periods
1.	**Introduction**		**04**
	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Design Requirements & Design Process, Advantages and limitations of WSM, Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.		
2.	**Design of tension members**		**06**
	Introduction, types of tension members, net area calculation. Design strength due to yielding, rupture and block shear. Design of tension members with welded and bolted end connection using single angle section & double angle section.		
3.	**Design of compression members and column bases**		**15**
	3.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	3.2	Design of axially loaded column using rolled steel sections, design of built up column, laced and battened Columns.	
	3.3	Design of slab bases & gusseted base.	
4.	**Design of beams and welded plate girder**		**13**
	4.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection. Design of angle section purlin.	
	4.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment, stiffeners and connections	
5.	**Design of connections**		**07**
	Design of bolted and welded beam to beam and beam to column connections.		

	Framed, stiffened and unstiffened seat, bracket connections.	
6.	**Design of truss**	**07**
	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing.	
	Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Explain the Limit State Design philosophy as applied to steel structures.
- Predict the behavior and design members subjected to axial compression, tension and their connection.
- Predict the behavior and design members subjected to bending, shear and their connection
- Calculate loading for a truss and design the complete truss.
- Demonstrate ability to follow IS codes, design tables and aids in analysis and design steel structures.
- Analyze and design the commercial steel structures and prepare drawing with complete detailing.

Theory examination:

1. Question paper will comprise of five questions. First question will **carry 32** marks and remaining four will carry **16 marks** each. The **first** question will be **compulsory.** From remaining four questions any **three** questions can be answered. Total **four** questions need be attempted.
2. The **first** question will be based on **any one** of design projects from following.

a) Design of Truss.
b) Design of flooring system.

3. The next four questions will be based on remaining modules of syllabus. The weightage of the marks shall be judiciously awarded in proportion to the importance of the module and number of hours allotted for the module. There can be an internal choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
4. For each question, the drawings will carry 20% weight of respective question. Drawings of questions **shall be drawn on half imperial drawing sheet** during the examination. The drawings of remaining questions may be drawn on drawing sheet or answer book.

5. All relevant IS codes will be allowed during examination.

Oral Examination:

The oral examination shall be conducted in conjunction with the sketching examination and it will be based upon the entire syllabus and the term work consisting of the assignments, projects including drawing sheets.

Term Work:

The Term work shall consist of following:

1. Design Report including detail drawings on any of the two projects as listed below:
    a) Design of truss (internal forces to be calculated by analytical method/graphical method/using any software)
    b) Flooring system including beam, column, column base and connections.
    c) Welded plate girder.

The drawing should be drawn in pencil only on minimum of A-1(imperial) size drawing sheets.

2. Neatly drawn minimum 15 sketches showing structural detailing based on entire syllabus(in sketchbook).
3. Neatly written assignments covering the syllabus. (At least four problems on each modules and contents thereof)
4. One site visit report (The report should contain structural details with sketches).viz. Industrial structure, Railway Structures, Workshops etc.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the design report, drawing work and assignments and minimum passing marks obtained by student. The following weightage of marks shall be given for different components of the term work.

- Design Report: 05 Marks
- Drawing sheets: 10 marks
- Assignments: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2. Limit state design of steel structures by S. K. Duggal, McGraw Hill Education(India) Pvt. Limited, New Delhi.
3. Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi
4. Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5. Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
6. Relevant Indian Specifications, Bureau of Indian Standards, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC603	**Transportation Engineering-II**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways railways. This course is developed so as to impart the basic principles behind railway engineering, airport engineering water transportation engineering in respect of their various types of materials used, function of component parts, methods of construction, planning principles, aspects of supervision maintenance.

Objectives

- To enable the students to study the various elements pertaining to air transportation, water transportation, railway transportation. To study the various components of railway track, materials used functions of component parts.
- To study the various imaginary surfaces of an airport, geometric standards, runway taxiway lighting.
- To study the various parking system, holding apron, hangars drainage system.
- To study the various modes of water transportation, types of breakwater, harbours and port facilities equipment.
- To study the various aspects of jetties, wharves, piers, dolphins, fenders buoyancy etc.
- To study the fundamental concepts of bridge engineering

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	General Introduction: Role of transportation in Society, objectives of transportation system, different types of modes, planning coordination of different modes for Indian conditions.		**10**
	Railway Engineering		
	1.1	Railways for urban transportation-Engineering surveys for track alignment-Obligatory Points-Conventional and modern methods (eg. Remote sensing, GIS)	
	1.2	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials.	
	1.3	Rails: coning of wheels, tilting of rails, rail cross sections, wear, creep of rails, rail fastenings.	
	1.4	Yards: details of different types of railway yards their functions.	
	1.5	Construction and maintenance of railway track, methods of construction, material requirements, maintenance of tracks, traffic operations.	
	1.6	Modernization of track and railway station for high speed trains, Mono rails and Metro rails.	
	1.7	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions, different ballast materials.	
2.	**Geometric Design of Railway and Traffic Control**		**08**
	2.1	Geometrics: gradients, transition curves, widening of gauge on curves, Cant deficiency.	
	2.2	Points crossing: design of turnouts, description of track junctions, different types of track junctions.	
	2.3	Signaling interlocking: classification of signals, interlocking of signals points, control of train movement.	

3.	**Airport Engineering**		**08**
	3.1	Aircraft component, their functions, aircraft characteristics and their influence on airport planning.	
	3.2	Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors affecting airport site selection.	
	3.3	Airport obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones.	
	3.4	Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers parking.	
	3.5	Airport marking and lighting marking, lighting of runways, taxiway, approach other areas.	
	3.6	Terminal area & airport layout: terminal area, planning of terminal buildings, apron: size of gate position, number of gate position, aircraft parking system, hanger, general planning considerations, blast considerations.	
4.	**Air Traffic Control**		**06**
	4.1	Air traffic control aids, en-route aids, landing aids.	
	4.2	Airport drainage: requirement of airport drainage, design data, surface drainage design.	
	4.3	Airport airside capacity delay: runway capacity delays, practical hourly capacity, practical annual capacity, computation of runway system, runway gate capacity, taxiway capacity,	
	4.4	Air traffic forecasting in aviation: forecasting methods, forecasting requirement applications.	
5.	**Water Transportation**		**03**
	Introduction of water transportation system, harbors docks, port facilities.		
6.	**Bridge Engineering**		**04**
	Bridge Engineering: Importance, Investigations, Site Selection, Different terms related with Bridges; Waterway, Afflux, Economic span, Scour depth,		

	Different types of bridges: Superstructures and sub-structures, Different loadings for design of bridges, Design requirements for high speed trains	
	Total	**39**

Contribution to Outcomes

On successful completion of this course, the students shall be able to:

- Understand the various systems of railway, airport, water transportation and the components of p-way and its construction, yards, modernization of railway track.
- Apply the concept of geometric design of railway track and railway traffic control.
- Understand airport planning, obstructions and orientation of runway.
- Apply the concept of geometric design of runway, taxiway, etc. and the knowledge of various signaling system for air traffic control.
- Understand the system of water transportation, types of breakwater, harbours and port facilities equipment
- Understand the basic idea about the bridge engineering.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. There can be an **internal** choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-module content thereof further. There shall be theory questions as well.

Distribution of Term-work Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. A Course of Railway Engineering: *Saxena, S. C. and Arora, S. P.*; Dhanpat Rai Sons, New Delhi.
2. Airport Planning Design: *Khanna, S.K., Arora, M.G.and Jain, J.J.; Nemchand Bros., Roorkee.*
3. Docks and Harbour Engineering: *Bindra, S. P.*; Dhanpat Rai and Sons, New Delhi.
4. Principles and Practice of Bridge Engineering: *Bindra, S.P.;*Dhanpat Rai and Sons, New Delhi.
5. Harbour, Dock and Tunnel Engineering: *Shrinivas, R.;*Charotar Publishing House, Anand
6. A Text Book on Highway Engineering Airports: Sehgal, S. E. and Bhanot, K. L., S. Chand and Co. Ltd., New Delhi
7. Airport Engineering: *Rao, G. V.,* Tata Mc-Graw Hill India Publishing House, New Delhi

Reference Books:

1. Indian Railway Track: *Agarwal, M. M.,*Suchdeva Press New Delhi.
2. Planning Design of Airport: *HoronjeffMckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
3. Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House
4. Bridge Engineering: Victor, D. J., Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi
5. Bridge Engineering: *Bindra, S. P.*, Dhanpatrai and Sons, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CE-C604	Environmental Engineering – II	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	**02**	**--**	**03**	**01**	**--**	**04**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**03**	**25**	**--**	**25**	**150**

Rationale

Environment has gained increasing importance in the relation with the principles of public health engineering, design of waste water collection and treatment systems; and develops rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of sewage processes and solid waste management. The course lays emphasis on complete update of the knowledge of these processes related to design of treatment plant.

Objectives

- To understand and explain the role of sanitation and its relation to public health and environment.
- To provide knowledge of wastewater collection system, characteristics of wastewater.
- To provide students the necessary knowledge and concepts of advancements/emerging techniques of treatment in physical, chemical and biological treatment processes. To provide students prerequisite knowledge necessary for higher studies and research in the field of wastewater treatment.
- To study the appropriate treatment, reclamation and resource recovery and re-use at both centralized and decentralized levels. Also, to study self-purification in nature.
- To develop rational approaches towards sustainable wastewater management via sludge recovery and treatments.
- To provide necessary skill for understanding and operation of solid waste management facilities.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Sewage Generation, Collection and Conveyance**		**10**
	1.1	**Introduction**: Need for sewerage system, Domestic sewage, Industrial waste and Storm Water, Conservancy and water carriage system, Systems of sewerage and their layouts: Separate, Combined and partially combined system, Merits and demerits, Patterns of sewerage layout, Quantity of sewage	
	1.2	**House drainage and Environmental sanitation** **Plumbing:** basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Systems of Plumbing, anti-siphonic and vent pipes.	
	1.3	**Conveyance of sewage** Sewer: Shapes and materials of sewers, open drains, Design of sewers: sewer size, Determination of velocity of flow using empirical formulae, limiting velocities. Laying and testing of sewers, Sewer joints, Sewer appurtenances, Ventilation of sewers. Construction and Maintenance of sewers. Pumping of sewage: Pumping station components	
2.	**Characterization and Primary Treatment of sewage**		**07**
	2.1	Need for Analysis, Characteristics of sewage: Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition, Sampling of sewage, Analysis of sewage. Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
3.	**Conventional Biological treatments**		**11**
	3.1	**Secondary Treatment Methods** Trickling filter- Principle, Process description and Operational problems and Design. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, Operational problems, Sludge volume index and	

		Design of ASP. Aerated lagoons- Process description and Design, Rotating Biological contractors, Stabilization Ponds, UASB.	
	3.2	**Constructed Wetland** Wetland and aquatic treatment systems; Types, application, Treatment Free water surface and subsurface constructed wetlands, Other aquatic treatment systems- Root zone technology, Duckweed ponds	
	3.3	**Septic Tank and Soak Pit** –Operation, suitability and Design. Concepts of advances in wastewater treatment. Imhoff Tank On-site treatment: Meaning of decentralized treatment.	
4.	**Reclamation and Reuse of Waste water**		**05**
	4.1	Tertiary and Grey water treatment, recycling and reuse of wastewater.	
	4.2	**Self-Purification of Natural Water Bodies** Oxygen economy, Sewage farming. Disposal of treated effluent Disposal of Raw and treated sewage on land and water, standards for disposal. Stream pollution: Self-purification, DO sag curve.	
5.	**Sludge Treatment and Disposal**		**03**
	5.1	Thickening, Dewatering, Sludge Digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks. Disposal- disposal of digested sludge, drying beds.	
6.	**Municipal Solid Waste Management**		**03**
	6.1	Solid waste: Sources, Types, generation and collection, storage, handling, transportation, processing, treatment and disposal methods Introduction to Hazardous wastes, E-wastes and Plastic wastes.	
		Total	**39**

Contribution to Outcomes

Having completed this course, the students shall ensure the safe handling and treatment of wastewater and sewage. The students shall be able to conduct quality control tests on samples obtained from sewer water, soil, nearby rivers and groundwater. The students shall be able to design the treatment facilities and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in most effective manner.

After the completion of the course the student should be able to:

- Explain wastewater collection systems in buildings and municipal areas and to determine the quantity of wastewater and storm water production. Also, gain the knowledge of the construction of new sewer line and importance of sewer appurtenances.
- Explain and analyze the characteristics of wastewater and design the primary treatment for wastewater
- Explain on-site treatment methods and solve Analyze and design wastewater treatment systems (ASP, Aerated lagoon and Oxidation ponds).
- Identify and apply proper treatment for reclamation and reuse of wastewater and disposal.
- Explain sludge characteristics and processing methods.
- To provide knowledge of solid waste collection system, characteristics of solid waste and to identify hazardous waste. Study related to plastic waste management will be studied.

Theory examination:

1. Question paper will comprise of **Six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total **four** questions need to be attempted.

List of Practical:(Any eight to be performed)

1. Determination of pH of sewage.
2. Determination of Chlorides.
3. Determination of Total Solids, suspended solids, dissolved solids, volatile solids.
4. Determination of Oil and Grease in waste water.
5. Determination of Dissolved oxygen.
6. Determination of Bio Chemical Oxygen Demand of sewage sample.
7. Determination of Chemical Oxygen Demand of sewage sample.

8. To find Sludge Volume Index (SVI) of sewage sample.
9. Plumbing demonstration of accessories, fittings and fixtures.
10. Solid waste: Determination of pH.
11. Solid waste: Determination of moisture content.

Term work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory along with the assignments. A brief report on the visit to sewage treatment plant shall also form a part of the term work.

Site Visit:

The student should visit to sewage treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

Mini Project :(Any one)

1. Identify sewer network of a particular area and study the case.
2. Collect the sample from municipal or industrial wastewater, test the parameters and suggest the treatment.
3. Identify the sewerage treatment facility in your area and suggest modification, innovation with design.
4. Identify plumbing system. Enlist sewer appurtenances and system requirement for row house or apartment.
5. A case study related to solid waste management or any waste minimization technique.
6. Model making in form of prototype with respect to sewage treatment or solid waste management.
7. Design of sewage treatment plant using software.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the site visit and the minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

The following weightage of marks shall be given for different components of the term work.

- Internal Oral examination based on Experiments and Assignments: 10 Marks

- Mini Project: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%; 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Oral Examination

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Recommended Books

1. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
2. Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
3. Environmental Engineering: *Peavy, H.S., RoweD.R., Tchobanoglous G.*; 1991, Tata-Mcgraw Hill.
4. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: *S. K. Garg,* Khanna Publishers New Delhi.
5. Water supply and sanitary Engineering: *Hussain S. K.,* Oxford and IBH Publication, New Delhi.
6. Plumbing Engineering, Theory and Practice: *Patil S. M.,* Seema Publication, Mumbai.
7. CPHEEO Manual on Sewage and Treatment.
8. Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
9. Relevant Indian standard specifications and BIS publications.
10. Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
11. Integrated solid waste management, Tchobanoglous, Theissen and Vigil, McGraw Hill Publication.
12. Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.
13. Water Supply and Sewerage: *E.W. Steel.*
14. Introduction to Environmental Engineering, *Vesilind*, PWS Publishing Company 2000.
15. Introduction to Environmental Engineering: P. *AarneVesilind*, *Susan M. Morgan*, Thompson.
16. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.

Semester VI

Subject Code	Subject Name	Credits
CEC605	Water Resources Engineering-I	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	**1**	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3	25	-	25	150

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This subject provides necessary knowledge about various irrigation methods based on crop water requirements, hydrologic processes, estimation of storage capacity of reservoir and hydraulics of wells.

Objectives

- To study various types of irrigation projects.
- To study and understand the various techniques and methods of irrigation.
- To understand the irrigation requirements of crops.
- To calculate storage capacity of reservoirs.
- To study the elements of hydrologic cycle and calculate catchment yield.
- To study the hydraulics of wells and ground water exploration methods.

Detailed Syllabus

Module	**Sub-Modules/ Contents**	**Periods**
1.	**Introduction:**	**6**
	Definition of irrigation, water resources in India, development of irrigation in India, need of irrigation in India, Benefits of irrigation, ill effects of irrigation, irrigation systems: major, medium and minor irrigation projects, command area	

	development, impact of irrigation on environment, national water policy.	
2.	**Irrigation methods and management** Types of irrigation: surface irrigation, subsurface irrigation; lift irrigation, bandhara irrigation, percolation tanks. Techniques of water distribution: free flooding, border flooding, check flooding, basin flooding, furrow irrigation method, micro irrigation, sprinkler irrigation, drip irrigation. Irrigation scheduling, participatory irrigation management.	**6**
3.	**Water requirement of crops:** Crops and crop seasons in India, cropping pattern, duty and delta, quality of irrigation water, soil water relationship, soil characteristics significance from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation, water requirement and capacity of canal and reservoir, assessment of irrigation water, water conservation, rain water harvesting.	**7**
4.	**Hydrology** Hydrologic cycle, Precipitation: Types of precipitations, measurement of rainfall by rain gauges, stream flow measurement, runoff, factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, runoff computations, flood discharge and calculations, unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph, complex hydrograph.	**8**
5.	**Ground water and well hydraulics:** Ground water resources, occurrence of ground water, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	**6**
6.	**Investigation and reservoir planning** Selection of site for reservoir, zones of storage reservoir, capacity elevation and area elevation curve of reservoir site, control levels, fixation of control levels, reservoir sedimentation, methods of control of sedimentation, evaporation loss, estimation and controlling methods of evaporation.	**6**
	Total	**39**

Contribution to Outcomes

On completion of this course the student will be able to:

- Classify various types of irrigation projects
- Explain different irrigation methods and effective use of water resources.
- Calculate the crop water requirements and irrigation requirement.
- Derive hydrographs and calculate runoff of a catchment area.
- Explain the steady state and unsteady state conditions of any aquifer and design water wells.
- Estimate the capacity of a reservoir for different purposes.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions out of remaining five questions.
5. Total **four** questions need to be solved.

Oral Examination:

The oral examinations shall be based on the entire syllabus including term work.

Term Work:

The term work shall comprise of the neatly written assignment/tutorials based on above modules. The assignment shall be covering the entire syllabus in such way that the student would attempt at-least three questions including numerical if any, on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance in tutorials and appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks

- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Irrigation and Water Power Engineering: *B.C. Punmia, Pande B.B. Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
3. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,* Ane Books Pvt. Ltd.ISBN, 9789383656899.
4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.
6. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand.
7. Engineering for Dams, Vol. I to III:*Crager, Justin and Hinds*, John Wiley.
8. Design of Small Dams: USBR.
9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross.
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6061	Department Level Optional Course-II-Advanced Construction Equipment	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	**2**	**-**	03	01	**-**	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Machines have revolutionised every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods used to construct facilities using modern equipment. It further exposes the student to different kinds of civil engineering structures which they are supposed to construct in the field and makes them aware with the equipment required for the same. The impact of use of equipment on human resource as well as how equipment will help in making optimum utilization of resources is also given a thought.

Objectives

- To illustrate the characteristics and complexities involved in large civil engineering projects.
- To classify various construction equipment
- To elaborate the various advanced equipment used on, below or above ground/water.
- To discuss about the various non-conventional construction techniques which make use of these advanced equipment.
- To discuss the utility of modern formworks systems over conventional systems.
- To select appropriate equipment and techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources etc.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction**		**06**
	Study of Different categories of construction equipment used conventionally with reference to available types and their capacities, operations and factors affecting their performance.		
	1.1	Earthmoving and other hauling equipment	
	1.2	Drilling and blasting equipment.	
	1.3	Pile driving equipment.	
	1.4	Pumping equipment (for water as well as concrete), Applications of Air compressor.	
	1.5	Dewatering techniques for trenches, tunnels.	
	1.6	Stone crushing equipment.	
2.	**Equipment for Underground and Underwater tunneling.**		**09**
	Various purposes for which tunneling may be carried out, Basic terms related to tunneling, Conventional methods of carrying out tunneling in different types of soils/rocks. Modern methods of tunneling and detailed study of following equipment/techniques in this regard:		
	2.1	Jumbo – used for drilling and blasting.	
	2.2	Vertical shaft sinking machine (VSM).	
	2.3	Tunnel Boring machine (TBM), Micro tunneling.	
	2.4	New Austrian tunneling method (NATM).	
	2.5	Cut & cover method, Top to bottom construction.	
	2.6	Tunnel lining trolley.	
3.	**Modern formwork systems**		**06**
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages.	
	3.2	Modular shuttering, Slip and jump form, Tower cranes and the benefits they offer for high rise construction.	
	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems.	
	Equipment for construction of underground utilities, road construction		

4.	**and bridges/flyovers**		**06**
	4.1	Pipeline insertion system, use of ground penetrating radar (GPR) for locating underground utilities.	
	4.2	Construction of roads using paver machines.	
	4.3	Methods of construction for bridges/flyovers and the processes/equipment required thereof, Incremental launching method and balanced cantilever method with reference to the recent infrastructure developed in the local and global context.	
5.	**Equipment/ techniques for setting up of power generation structures.**		**06**
	5.1	Hydropower station.	
	5.2	Thermal power station.	
	5.3	Solar power station.	
	5.4	Atomic power generation.	
	5.5	Installation and operation of wind mills.	
	5.6	Installation and operation of underground power transmission lines as well as overhead transmission towers.	
6.	**Equipment for construction of transporting facilities**		**06**
	4.4	Construction of railway lines using track laying machine. Methods, techniques and equipment involved in the construction of Metro, mono and maglev trains. Special requirements of the permanent way in each case.	
	4.5	Equipment required for construction and operation of an airport and sea port.	
		Total	**39**

Contribution to Outcomes

On successful completion of this course, students shall be able to:

- Understand the use/applications of various conventional construction equipment and select the best out of them for a particular site requirement.
- Know modern methods/equipment used for underground as well as underwater tunnelling.
- Compare conventional and modern methods of formwork on the basis of productivity, reuse value, ease of erection and dismantling, flexibility offered and overall cost.

- Understand the techniques involved and the equipment required thereof for construction of various transporting facilities.
- Gain knowledge about the setting up of different kinds of the power generating structures.
- Select proper equipment for construction of transporting facilities based on requirements.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term work shall comprise of the neatly written report based on assignments (One for each module) and site visits (minimum 2). The assignments shall be given covering the entire syllabus and preferably different questions can be given to different group of students so that they themselves will create the question bank and answers for the same.

This course should be taught through maximum site visits and demonstration of the working processes and equipment through animations/videos to make the delivery most effective. The difference between conventional and modern method of carrying out a construction process should be clearly known to the students. Site visits to various ongoing infra projects especially in Mumbai Metropolitan region (MMR) can be of great help to the students. The site visits should be planned in such a way so that maximum equipment/techniques can be seen actually by the students. The report on site visit shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report on Site Visits: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books/Study material:

1. Construction Equipment & Planning, Purifoy, R.L & Ledbetter, McGraw Hill
2. Construction Equipment & it's Management, Sharma, S. C. Khanna Publishers
3. Tunnel Engineering Handbook, Thomas R. Kuesel, Elwyn H. King, John O. Bickel, Springer
4. Practical tunnel construction, Gary B. Hemphill, Wiley Publishers
5. Construction Technology for Tall Buildings, Michael Yit Lin Chew, World Scientific
6. The prefabricated home, Colin Davies, Reaktion Books.
7. Literature/specifications/downloadable videos available on Doka and Mivan shuttering websites.
8. Accelerated Bridge Construction: Best Practices and Techniques, Mohiuddin Ali Khan, BH Elsevier
9. Design and Construction of Nuclear Power Plants, RüdigerMeiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6062	Department Level Optional Course-II-Traffic Engineering and Management	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Transportation Planning is a backbone of the urban planning or town planning. It constitutes the important part of any urban or town system. Traffic Engineering follows the Transportation Planning and is the specialized branch of the Highway Engineering which deals with the improvement of traffic performance on road network and terminals through systematic traffic studies, scientific analysis and engineering applications. Traffic Engineering includes the planning and geometric design on one hand and regulation and control on the other. It, therefore, deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

- To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one; and further, the application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.
- To understand the concept of various features of the highway geometrics and infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.
- To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.

- To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.
- To study the various components of the Transportation Planning process, their importance and various approaches/ methods/ models to be resorted to for each of these components.
- To understand the concept of economic evaluation of any of the transportation projects, its significance, various aspects associated with the evaluation; and various methods of economic evaluation.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Traffic Engineering**		08
	1.1	**Traffic Characteristics/ Characteristics of the Users of the Transportation System** Introduction to the Road User and the Vehicle; Road Users' (Human) Characteristics affecting their behavior; Vehicular Characteristics; Power Performance of Vehicles.	
	1.2	**Traffic Studies/ Surveys** Introduction to Spot Speed (space and time mean speed); Speed and Delay Studies (different types of delays, overall/ journey speed, running speed, journey time, running time); Traffic Volume Studies; Vehicle Occupancy Studies; Parking Studies; Accident Studies. Significance/ Objectives/ Necessity/ Application of the afore-mentioned studies; Methods of conducting these studies along with pros and cons (merits and drawbacks) of each of methods; Analysis Methodologies; Different methods of the Interpretation / Presentations of the Results.	
	1.3	**Application of Statistical Methods in the Traffic Engineering** Different Statistical Methods; Basic Concepts of the Terminologies pertaining to statistical methods; Poisson's, Binomial and Normal Distribution, Sampling theory and Significance Testing, Regression (Linear and Multiple) and Correlation	

2.		**Highway Geometrics and Parking System**	07
	2.1	Different Terms involved in Highway Geometrics; Types of Intersections (At grade and grade separated) and its further bifurcations/ classification along with merits and drawbacks; Conflict points and Conflict Area at Intersections; Flaring of Intersections; Principles behind designing the intersections. Channelization: Significance, Different types of islands within the layout of the road network and intersection or junctions. Speed Change Lanes; Rotary intersection: Merits and Demerits; Necessity; Different Types; Design Principle; Design of the Rotary.	
	2.2	Traffic and parking problems; different types of parking facilities (on street and off street along with further bifurcations therein); Truck Terminals; Long distance Bus Terminals.	
3.		**Highway Capacity and Introduction to Theory of Traffic Flow**	04
		Capacity; Difference between Capacity and Volume; Passenger Car Unit (PCU); Concept of Level of Service; Different Types of Capacities and Factors affecting the Capacity. Speed- flow-Density Relationships; Introduction to the Lighthill and Whitham’s Theory; Car Following Theory and Queuing Theory	
4.		**Highway Safety/ Traffic System Management/ Lighting**	07
	4.1	Factors responsible for the accident; Preventive Measures; Traffic Management Measures and its implications on traffic flow and accident prevention Brief Introduction to the Highway Lighting: Importance; Principle of Visibility at Night; Factors influencing Night Visibility; Design Factors; Important Definitions; Law of Illumination; Discernment by Artificial Lighting; Mounting Height; Spacing; Lantern Arrangements; Types of Lamps; Lighting of Some Important Highway Structures; Design of Highway Lighting Systems.	
	4.2	**Traffic Control Devices (Signs, Signals and Marking)** Significance; Advantages and Drawbacks; Principles of TCDs; Different Types of Traffic Signs; Different Types of Traffic Signals; Terms	

	involved in Signals; Co-ordinated Control of Signals and Types of Co-ordinated Signal System; Various Approaches of Designing the Signals (determination of optimal cycle time and signal setting for an intersection with fixed time signals); Area Traffic Control and Delay at Signalized Intersections.	
5.	**Transportation Planning**	**07**
	Introduction to the process of urban transport planning. Trip Generation: Introduction; Factors affecting Traffic Generation and Attraction Rates; Multiple Regression Analysis, Category Analysis Trip Distribution: Importance; Different Methods of Trip Distribution, Uniform and Average Factor Method, Fratar Method, Furness Method, Gravity model, Opportunities Model. Traffic Assignment: Purpose; General Principles; Assignment Techniques (All or Nothing Assignment, Multiple Route Assignment, Capacity restraint assignment, Diversion Curves). Modal Split: General Considerations; Factors affecting Modal Split; Modal Split in the Transportation Planning Process Land Use Transport Models: Introduction; Selection of Land Use Transport Models; Lowry Derivative Models; Garin Lowery Model	
6.	**Transport Economics**	**06**
	Economic Evaluation of Transportation Projects; Necessity; Cost and Benefits of Transportation Projects, Basic Principles of Economic Evaluation, Interest Rate; Costs (Vehicle Operating; Time; Accident); Benefits (Direct and Indirect); Different Methods of Economic Evaluation (Benefit- Cost Ratio Method, First Year Rate of Return Method; Net present Value Method; Internal rate of Return Method); Comparison of the Various Methods of Evaluation vis-a-vis.	
	Total	**39**

Contribution to Outcomes

After successful completion of the course the students shall be able to

- Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
- Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
- Explain the concepts of PCU and LoS, their implication in determination of the capacity using Speed-Flow-Density relationships.
- Discuss the aspects associated with highway safety and different TSM measures.
- Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
- Plan the various features of highway geometrics and transportation infrastructure constituents to ensure safe, rapid, economical and efficient of the traffic.

Theory Examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. All the questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
3. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics and to give justice to all the contents of the entire syllabus.
4. The **first** question will be **compulsory**. The students will have to attempt any **three** questions out of remaining **five** questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work prepared by the student and appropriately certified by the course instructor/ teacher concerned.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems/questions on each sub-modules and contents thereof further. Apart from this, the students shall conduct at least three traffic surveys and shall prepare a detailed report of the analysis of these surveys. This report shall also form a part of the term work.

Distribution of the Term Work Marks:

The marks of term work shall be judiciously awarded for various components depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report of the Traffic Surveys: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, the following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Traffic Engineering and Transportation Planning: Kadiyali L. R., Khanna Publishers, Delhi.
2. Principles of Traffic Engineering: Pignataro, G. J., McGraw-Hill
3. Traffic System Analysis for Engineering and Planners: Wohl and Martin, Mc-Graw Hill
4. Highway Engineering: Khanna, S.K.; Justo, C.E.G. and Veeraraghavan, A.; Nemchand and Bros., Roorkee (10th Revised Edition)
5. Principles of Transportation Engineering: ParthaChakroborty and Animesh Das, Prentice Hall (India).
6. Highway Engineering and Traffic Engineering: Saxena, Subhash C.; C.B.S. Publishers
7. Transportation Engineering (Vol.-I): Venkatramaiah, C.; University Press, Hyderabad
8. Principles, Practice and Design of Highway Engineering: Sharma, S.K.; S Chand and Co. Pvt. Ltd., Delhi
9. Highway Engineering: Sriniwaskumar, R.; University Press, Hyderabad
10. Traffic Flow Theory and Control: Drew, D. R., Mc-GrawHill, New York

11. Transportation Engineering and Planning: Papacostas, C. S., Prevedouros, P. D., PHI Learning Pvt. Ltd.
12. Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt. Ltd.
13. Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.; McGraw-Hill.
14. Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, New York.
15. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
16. Relevant IRC Codes amended time to time.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6063	Department Level Optional Course-II: Ground Improvement Techniques	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

A geotechnical engineer often needs to design new structures or repair the structures on or in problematic soils in engineering practices. The types of soil at construction sites are not always totally favorable for supporting civil engineering structure such as buildings, bridges, highways, tunnels, retaining walls, dams, offshore structures and many more. Soil needs to be treated using ground improvement techniques to enhance the soil strength. Similarly, specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. For both cases, the knowledge of Ground Improvement is required as ground improvement is an important to for a Geotechnical Engineer. This course will deal with different ground improvement techniques along with principles, design issues and construction procedures.

Objectives

- To enable students to identify problematic soils and their associated issues.
- To make the student understand for different ground improvement methods adopted for improving the properties of in-situ and remoulded soils.
- To make the student learn the concepts, purpose, methods and effects of soil stabilization.
- To make the student learn the concepts, purpose and effects of grouting.
- To provide the concepts of the reinforced earth and soil nailing to the students in conventional retaining walls.
- To enable the students to know ground anchors that can be used to improve the engineering performance of soils both in static and seismic condition

Detailed Syllabus

Module	Sub Modules/Contents	Periods
1.	**Introduction**	**04**
	Need for Ground Improvement, Different types of problematic soils, classification of ground improvement techniques, Emerging trends in ground Improvement techniques, economic considerations and suitability.	
2.	**Compaction and Consolidation**	**07**
	Methods of compaction, Shallow compaction, Deep compaction techniques: Vibro-floatation, Blasting, Dynamic consolidation, pre-compression; accelerated consolidation by sand drains, free strain and equal strain cases, design of sand drain layout.	
3.	**Stabilization of Soil**	**05**
	Methods of stabilization, mechanical stabilization: lime, cement, lime, fly-ash, bitumen, chemicals and polymer stabilization, stabilization by electro-osmosis.	
4.	**Grouting**	**06**
	Grouting technology, Grout materials, physical and chemical properties, strength, Rheological aspects of coarse and fine grouts, penetrability and performance aspect of coarse and fine grouts, Various application of grouting.	
5	**Stone Columns**	**08**
	Application, layout feature, procedures of installation, vibro float and rammed stone column, unit cell concept, load transfer mechanism, settlement in stone column, methods of improving the effectiveness of stone column, Design for stone column layout.	
6.	**Reinforced Earth and Anchors**	**09**
	Necessity of reinforced earth, theory of reinforced earth, materials and method, application, design of reinforced earth, characteristics of reinforced earth masses; introduction to soil nailing and ground anchors; Capacity of shallow horizontal and vertical strip anchors by using Mononobe-Okabe method.	
	Total	**39**

Contribution to Outcomes

After successful completion of the course students will be able to:

- Identify problematic soils and their associated issues.
- Study the various ground improvement techniques and propose suitable remedial techniques and design.
- Select appropriate soil improvement technique based on the soil type and application.
- Design grouting for various engineering applications in the field.
- Design stone column layout
- Design the geotechnical structures with the pseudo-static method under seismic condition

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on assignments. The term work shall cover the entire syllabus in such a way that the students would attempt conceptual theory part from each module. Further, groups of students (having maximum four students) shall be formed who shall analyse and design any **three** with different data from the following:

1. Design of sand layout in soft compressible clay deposit for required (accelerated) rate of consolidation.
2. Analysis of Horizontal or Vertical strip anchor by using Mononobe-Okabe Method to find the seismic capacity.
3. Design of a reinforced earth retaining wall.
4. Analysis and design of skirted stone columns.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report on Analysis and Design: 10 Marks
- Attendance: 5 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to:

- 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Ground Improvement Techniques: P.P. Raj, Prentice Hall of India, (2005).
2. Engineering Principles of Ground Modification: M.R. Housmann, McGraw Hill, (1990).
3. Foundation Engineering Manual: N. V. Nayak, (2015).
4. IS15284 (Part 1): Design and Construction for Ground Improvement–Guidelines: (Stone Column), Bureau of Indian Standards, New Delhi, (2003).
5. Ground Improvement Techniques: Nihar Ranjan Patro, Vikas Publishing House (P) Limited, (2012).
6. Geotechnical Earthquake Engineering: S. L. Kramer, Pearson, (2013).
7. Earth Anchors: B. M. Das, Elsevier, (2012).

Reference books:

1. Constructional and Geotechnical Methods in Foundation Engineering: R.M. Koerner, McGraw Hill, (1985).
2. Design and Construction of Stone Column: FHWA Report No. Rd 83/026, (1983)

3. Principles of Foundation Engineering: B. M. Das, 7th edition, Cengage Learning, (2013).
4. Designing with Geosynthetics: R.M.Koerner,4th Edition,Prentice Hall, Jersey, (1999)

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6064	Department Level Optional Course-II: Advanced Structural Analysis	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	-	25	150

Rationale

There are various types of the civil engineering structures which are subjected to various types of loading and their combination. Most of the structures are indeterminate. There are various advances in methods to analysed these structures. The methods of analysis which are given in the syllabus are based on computer software.

Objectives

- To analyze the statically indeterminate portal frame.
- To study the methods and evaluating rotation and displacement parameters in complete frame using various methods.
- To analyze the symmetrical frame with symmetrical and anti-symmetrical loading.
- To understand the concept of analyze of non-prismatic frame and beam.
- To understand the concept of Influence lines for statically indeterminate beams.
- To understand in depth the stiffness matrix method of analysis, which is the basis of all compute-based software methods used in practice; finite element method, concepts thereof, different elements to be used along with various shape functions and solution methodology.

Detailed Syllabus

Module	Sub-Modules / Contents		Periods
1.	**Introduction to Stiffness Method in Matrix form**		**10**
	1.1	Basic concepts of stiffness coefficients, member stiffness matrix for beam, member stiffness matrix for plane truss, member stiffness matrix for rigid jointed plane frame, member stiffness matrix for plane grid and of space frame.	
	1.2	Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	
	1.3	Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members	
	1.4	Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	
2.	**Conventional Form of Stiffness Method, Modified Moment Distribution Method**		**07**
	2.1	Symmetrical structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames involving side sways.	
3.	**Flexibility Method in Matrix form**		**04**
	3.1	Review of concepts of flexibility coefficients, Flexibility member matrix for beam, member flexibility matrix for plane truss, member flexibility matrix for rigid jointed plane frame, member flexibility matrix for plane grid and of space frame.	
	3.2	Selection of primary structure, concepts of flexibility matrix, compatibility equation, solution for redundant forces, computational of internal forces, and joint displacement. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports.	

4.	**Conventional Form of Flexibility Method**		**07**
	4.1	Elastic Centre Method and its application to rectangular box, and rigid jointed portal frames.	
	4.2	Column Analogy Method and its application to analysis of non-prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non-prismatic beam members.	
5.	**Influence Line Diagrams for Indeterminate Structures**		**05**
	Muller Breslau’s Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams.		
6.	**Introduction to Finite Element Method**		**06**
	6.1	Brief History of the Development; Advantages & Disadvantages of Finite Element Method.	
	6.2	Different elements (1-D, 2-D, 3-D, CST Elements); Shape Functions & Interpolation Polynomials for two nodded bar and beam elements; Stiffness Matrix for the basic Bar & Beam Element, Solution Methodology.	
Total			**39**

Contribution to Outcomes

The students will be able to

- Understand the Stiffness Matrix method and will be able to analyze various types of structures by this method understand the conventional methods of analysis.
- Understand the methodology involved in commercially available computer software for analysis which are based on stiffness matrix method.
- Obtain the response of the indeterminate beams under the action of moving loads.
- Evaluate the displacement/ deflection in frames under the action of loads.
- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG program courses, in which they will be dealing with the indeterminate structures.
- Understand the concepts of the finite element method toward solving the problem, different elements and shape functions (displacement functions) to extend the application to the short problems.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short question having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.

At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 marks
- Attendance: 5 marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks.

Recommended Books:

1. Basic Structural Analysis: Reddy C. S. Tata McGraw hill.
2. Analysis of Framed Structures: Gere and Weaver, East-West Press
3. Analytical Methods in Structural Analysis: S. A. Raz, New Age Int Publishers
4. Modern Method in structural Analysis: Dr. B. N. Thadani and Dr. J. P. Desai, Weinall Book Corporation.
5. Sructural Analysis: L. S. Negi & R. S. Jangid, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: Pandit and Gupta, Tata McGraw hill.
7. Analysis of Structures: V.N.Vazirani and M.M.Ratwani Khanna Publishers.
8. Finite Element Analysis: S.S. Bhavikatti, New Age International Publication

Reference Books:

1. Matrix Method in structural Analysis: Livesley R. K. Pergamon Press, London.
2. Elementary Structural Analysis: Wilber, M MethodGraw Hill, New York.
3. Plastic Method of Structural Analysis: B. G. Neal, Chapman and Hall, London.
4. Intermediate Structural Analysis: Wang C. K., Tata McGraw hill
5. Matrix Method of Structural Analysis: Dr. A. S. Meghre, S. K. Deshmukh, Charotar Publishing House.
6. Finite Element Analysis: S. Rajasekaran, S. CHAND & COMPANY PVT. LTD
7. Finite Element Method with application in Engineering Y.M.Desai, T. I. Eldho and A.H, Shah PEARSON
8. Finite Element Method: Daryl L. Logan, THOMSON
9. Matrix Structural Analysis: William McGuire, Richard H. Gallagher, Ronaid D. Ziemian, Wiley India Pvt. Ltd.

Semester VI

Subject Code	Subject Name	Credits
CEC607	**Software Applications in Civil Engineering**	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	2	-	-	1	-	1

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	**25**		25	**50**

Rationale

With the advancements in software and technology, a significant revolution in Civil Engineering field has taken place. Software reduces all the extensive work, specifically through the introduction of programs and applications. Lately, software development has effectively contributed in various Civil Engineering disciplines. It provides engineers with the ability to perform variety of complex calculations, modelling, drafting, design practices and analytical processes with utmost ease. Further these software packages have wide capabilities and help engineers to analyze, design, plan and monitor projects, which earlier was a cumbersome job. Civil Engineering students need to learn all skill sets and demonstrate the practical applications to Engineering problems. Hence this course covers the study of various types of software packages and their application in Civil Engineering fields.

Objectives

Students are introduced to:

- All kinds of software packages available in various fields of civil engineering.
- Proficiency in applications of these software packages.
- Practical use of software results and their validation by relating them with analytical results by conventional methods.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**General**		02
	1.1	Importance and need of software for modeling, analysis and design in Civil Engineering field, Advantages and limitations of software, causes for errors, validation of software results. Failures due to errors in modeling, data entry and interpretation of software results.	
2.	**Software application in various disciplines of Civil Engineering:** Learning and practice of any one software from at least any 4 domain from 14 domain (2.1 to 2.14)		24
	2.1	**Drafting and drawing**: AutoCAD, Civil 3D, Auto plotter, Design and detailing of same using AutoCAD Beams (simply supported, continuous etc), Slabs (one way, two way), Columns, Portal frame, Truss	
	2.2	**building information modelling**: Revit and archicad, tekla , Navisworks, Trimble, AECOsim Building designer , Sketchup	
	2.3	**Numerical Analysis and Mathematical operations:** MATLAB Scilab	
	2.4	**Structural Analysis and Design:** STAAD Pro, ETABS, SAP 2000, SAFE, MIDAS.	
	2.5	**Finite Element Analysis**: ANSYS, ABAQUS, NISA	
	2.6	**Project Management:** Primavera, MS Project	
	2.7	**Geotechnical Engineering: Geo** studio, PLAXIS	
	2.8	**Quantity Surveying:** QS red, CCS Candy	
	2.9	**Environmental Engineering:** Storm CAD, EPANET, Sewer CAD	
	2.10	**Remote Sensing and Geographical Information System:** QGIS, GRAM++, Arc GIS	
	2.11	**Transportation Engineering:** MX Road, HDM, Road estimator	
	2.12	**Hydraulics and Water Resources Engineering**: Water Gems, Water CAD, Flow Master, Culvert Master, Nero solution, Discipulus, HEC-RAS, Arc SWAT, Hydrology: HEC, HMS	
	2.13	Different Open source software used for specific problems	

	2.14	**MS Excel:** Conduct concrete mix design for M40 grade concrete. or any exercise of Civil Engineering domain.	
		Total	**26**

Note: Course Owner is free to add and teach any latest additional software which is relevant to Civil Engineering Field and not listed in above curriculum.

Contribution to Outcome

After completion of the course, the students will be able to:

- Use the software in various disciplines of Civil Engineering
- Apply the software in to provide solutions to field problems.
- Validate the software results using judgment about range of answers.
- Identify theappropriate software application based on the field of Civil Engineering
- Apply equivalentopen source software based on thecase ofCivil Engineering specific problems.
- Integrate different softwares and their results for specific problems of Civil Engineering.

Term Work

A group of 3-4 students will prepare and give detailed power point presentation on any one software. Presentation should cover salient features, capability of software and should contain some applications from field.

The term work shall comprise of:

- At least hands-on working on one Software from any fourdomain listed above and preparing report of the same.
- Presentation Report on any one software.
- Open Source Software report (optional)

Distribution of the Term Work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the design report/ assignments and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work:

- Software Report: 16 marks
- Presentation: 4 marks
- Attendance: 5 marks

Further, while giving weight age of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended reading:

1. Software manuals.
2. Refereed Journal papers on Software applications.
3. NPTEL course like “ MATLAB programming for numerical computation by Dr.NiketKaisare from IIT Madras and so on for other softwares.

AC:

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Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC:

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Sr. No.	Heading	Particulars
1	Title of the Course	**Fourth Year Engineering (Computer Engineering)**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~/ Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year:2021-2022**

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner’s learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

Dr. S.K. Ukarande

Associate Dean

Faculty of Science and Technology

University of Mumbai

Dr Anuradha Muzumdar

Dean

Faculty of Science and Technology

University of Mumbai

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Incorporation and Implementation of Online Contents fromNPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C’ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

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Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Engineering syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud : Chairman
Prof. SunitaPatil : Member
Prof. LeenaRaga : Member
Prof. Subhash Shinde : Member
Prof .Meera Narvekar : Member
Prof. Suprtim Biswas : Member
Prof. Sudhir Sawarkar : Member
Prof. Dayanand Ingle : Member
Prof. Satish Ket : Member

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Program Structure for Fourth Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC701	Machine Learning	3	--	3	--	3
CSC702	Big Data Analytics	3	--	3		3
CSDC 701X	Department Level Optional Course-3	3	--	3	--	3
CSDC 702X	Department Level Optional Course-4	3	--	3	--	3
CSIO701	Institute Level Optional Course-1	3	--	3	--	3
CSL701	Machine Learning Lab	--	2	--	1	1
CSL702	Big Data Analytics Lab	--	2	--	1	1
CSDL 701X	Department Level Optional Course-3 Lab	--	2	--	1	1
CSDL 702X	Department Level Optional Course-4 Lab	--	2	--	1	1
CSP701	Major Project 1	--	$6^{\#}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC701	Machine Learning	20	20	20	80	3	--	--	100
CSC702	Big Data Analysis	20	20	20	80	3	--	--	100
CSDC 701X	Department Level Optional Course-3	20	20	20	80	3	--	--	100
CSDC 702X	Department Level Optional Course-4	20	20	20	80	3	--	--	100
CSIO701	Institute Level Optional Course-1	20	20	20	80	3	--	--	100
CSL701	Machine Learning Lab	--	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	--	25	25	50
CSDL 701X	Department Level Optional Course-3 Lab						25	-	25
CSDL 702X	Department Level Optional Course-4 Lab	--	--	--	--	--	25	-	25
CSP701	Major Project 1	--	--	--	--	--	50	25	75
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**725**

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Program Structure for Fourth Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
CSC801	Distributed Computing	3	--	3	--	3
CSDC 801X	Department Level Optional Course -5	3	--	3	--	3
CSDC 802X	Department Level Optional Course -6	3	--	3	--	3
CSIO801	Institute Level Optional Course -2	3	--	3	--	3
CSL801	Distributed Computing Lab	--	2	--	1	1
CSDL 801X	Department Level Optional Course -5 Lab	--	2	--	1	1
CSDL 802X	Department Level Optional Course -6 Lab	--	2	--	1	1
CSP801	Major Project 2	--	$12^{\#}$	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC801	Distributed Computing	20	20	20	80	3	--	--	100
CSDC 801X	Department Level Optional Course -5	20	20	20	80	3	--	--	100
CSDC 802X	Department Level Optional Course -6	20	20	20	80	3	--	--	100
CSIO801	Institute Level Optional Course -2	20	20	20	80	3	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	--	25	25	50
CSDL 801X	Department Level Optional Course -5 Lab	--	--	--	--	--	25	25	50
CSDL 802X	Department Level Optional Course -6 Lab						25	25	50
CSP801	Major Project 2	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**175**	**125**	**700**

Major Project 1 and 2 :

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load : In Semester VII – ½ hour per week per project group
  In Semester VIII – 1 hour per week per project group

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Program Structure for Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VII	Department Optional Course -3	CSDC7011: Machine Vision CSDC7012: Cyber Security CSDC7013: Natural Language Processing
	Department Optional Lab -3	CSDL7011: Machine Vision Lab CSDL7012: Cyber Security Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course -4	CSDC7021 : Augmented and Virtual Reality CSDC7022 : Block Chain CSDC7023 : Information Retrieval
	Department Optional Lab -4	CSDL7021 : Augmented and Virtual Reality Lab CSDL7022 : Block Chain Lab CSDL7023 : Information Retrieval Lab
	Institute level Optional Courses-I	

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Program Structure for Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VIII	Department Optional Course -5	CSDC8011 : Deep Learning CSDC8012 : Digital Forensic CSDC8013 : Applied Data Science
	Department Optional Lab -5	CSDL8011 : Deep Learning Lab CSDL8012 : Digital Forensic Lab CSDL8013 : Applied Data Science Lab
	Department Optional Course -6	CSDC8021 : Optimization in Machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab -6	CSDL8021 : Optimization in Machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	

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Course Code:	Course Title	Credit
CSC701	Machine Learning	3

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives:	
1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.
Course Outcomes:	
1	To acquire fundamental knowledge of developing machine learning models.
2	To select, apply and evaluate an appropriate machine learning model for the given
3	To demonstrate ensemble techniques to combine predictions from different models.
4	To demonstrate the dimensionality reduction techniques.

Module		Content	Hrs
1		Introduction to Machine Learning	04
	1.1	Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	
	1.2	Training Error, Generalization error, Overfitting, Underfitting, Bias-Variance trade-off.	
2		Learning with Regression and Trees	09
	2.1	Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression.	
	2.2	Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART)	
	2.3	Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve	
3		Ensemble Learning	06
	3.1	Understanding Ensembles, K-fold cross validation, Boosting, Stumping, XGBoost	
	3.2	Bagging, Subagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers	
4		Learning with Classification	08
	4.1	Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, Quadratic	

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		Programming, SVM for linear and nonlinear classification, Basics of Kernel trick.	
	4.2	Support Vector Regression, Multiclass Classification	
5		Learning with Clustering	07
	5.1	Introduction to clustering with overview of distance metrics and major clustering approaches.	
	5.2	Graph Based Clustering: Clustering with minimal spanning tree Model based Clustering: Expectation Maximization Algorithm, Density Based Clustering: DBSCAN	
6		Dimensionality Reduction	05
	6.1	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	
		Total	39

Textbooks:	
1	Peter Harrington, “Machine Learning n Action”, DreamTech Press
2	Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3	Tom M. Mitchell, “Machine Learning” McGraw Hill
4	Stephen Marsland, “Machine Learning An Algorithmic Perspective”, CRC Press
References:	
1	Han Kamber, —Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2	Margaret. H. Dunham, —Data Mining Introductory and Advanced Topics, Pearson Education
3	Kevin P. Murphy , Machine Learning — A Probabilistic Perspective‖
4	Samir Roy and Chakraborty, —Introduction to soft computing‖, Pearson Edition.
5	Richard Duda, Peter Hart, David G. Stork, “Pattern Classification”, Second Edition, Wiley Publications.
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
2	Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3	Machine Learning from Coursera
4	https://towardsdatascience.com/machine-learning/home
5	https://onlinecourses.nptel.ac.in/noc21_cs85/preview

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Course Code	Course Name	Credit
CSC702	**Big Data Analysis**	**03**

Prerequisite: Database, Data mining.	
Course Objectives: The course aims:	
1	To provide an overview of the big data platforms, its use cases and Hadoop ecosystem.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL and R
3	To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex real-world problems for decision support.
Course Outcomes:	
1	Understand the building blocks of Big Data Analytics.
2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
3	Understand different NoSQL systems and how it handles big data.
4	Apply advanced techniques for emerging applications like stream analytics.
5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
6	Apply statistical computing techniques and graphics for analyzing big data.

Module		Detailed Content	Hours
1		**Introduction to Big Data and Hadoop**	2
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data	
	1.2	Traditional vs. Big Data business approach	
	1.3	Case Study of Big Data Solutions	
	1.4	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem	
2		**Hadoop HDFS and MapReduce**	8
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization.	
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union ,Intersection,	

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		and Difference by MapReduce	
	2.4	Hadoop Limitations	
3		**NoSQL**	10
	3.1	Introduction to NoSQL, NoSQL Business Drivers	
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study	
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	
4		**Mining Data Streams**	11
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.	
	4.2	Sampling Data techniques in a Stream	
	4.3	Filtering Streams: Bloom Filter with Analysis.	
	4.4	Counting Distinct Elements in a Stream,Count-Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements	
	4.5	Counting Ones in a Window: The Cost of Exact Counts,The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in theDGIM Algorithm, Decaying Windows.	
5		**Real-Time Big Data Models**	4
	5.1	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering	
	5.2	Case Study: Product Recommendation	
	5.3	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph	
6		**Data Analytics with R**	4
	6.1	Exploring Basic features of R, Exploring RGUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and using Objects, Interacting with users, Handling data in R workspace, Executing Scripts, Creating Plots, Accessing help and documentation in R	
	6.2	Reading datasets and Exporting data from R, Manipulating and Processing Data in R, Using functions instead of script, built-in functions in R	
	6.3	Data Visualization: Types, Applications	

Textbooks:	
1	Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets‖, Cambridge UniversityPress
2	Alex Holmes —Hadoop in Practice‖, Manning Press, Dreamtech Press.
3	Dan Mcary and Ann Kelly —Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4	DT Editorial Services, “Big Data Black Book”, Dreamtech Press

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5	EMC Education Services,"Data Science and Big Data Analytics",Wiley

References:

1	Bill Franks , —Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics‖,Wiley
2	Chuck Lam, —Hadoop inAction‖, Dreamtech Press
3	Jared Dean, —Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners‖,Wiley India Private Limited, 2014.
4	Jiawei Han and Micheline Kamber, —Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
5	Lior Rokach and Oded Maimon, —Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010.
6	Ronen Feldman and James Sanger, —The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.
7	Vojislav Kecman, —Learning and Soft Computing‖, MITPress, 2010.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/specializations/big-data#courses
3	https://www.digimat.in/nptel/courses/video/106106169/L01.html
4	https://www.coursera.org/learn/nosql-databases#syllabus
5	https://www.coursera.org/learn/basic-recommender-systems#syllabus

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Course Code	Course Name	Credit
CSDC7011	**Machine Vision**	**03**

Pre-requisite: Computer Graphics	
Course Objectives: The course aims:	
1	To understand the need and significance Machine Vision
2	To explore basics of image processing
3	To explore the components of Machine Vision System
4	To develop application using machine Vision
5	To study transformation, interpolation, filters.
Course Outcomes: Learners will be able to	
1	Elaborate the components of Machine Vision Application
2	Perform image ,video preprocessing operations
3	Explain various transformations, interpolation.
4	Elaborate motion tracking in video.
5	Analyze and Implement appropriate filtering techniques for a given problem.
6	Develop applications based on machine vision..

Module		**Detailed Content**	**Hours**
1		**Introduction to Machine Vision**	4
		Computer and Human Vision Systems., The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision	
2		**Digital Image Fundamentals**	8
		Digital Image, Monochrome and Color Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation , Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices , Point Operations , Thresholding ,Brightness, Geometric Transformations , Spatial Transformation , Affine Transformation, Image Interpolation ,Nearest-Neighbor Interpolation ,Bilinear Interpolation , Bi-cubic Interpolation ,Fundamental Steps in Digital Image Processing.	
3		**Machine Vision and System Components**	8

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		Machine Vision System, Machine Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens-Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Machine Vision, Illumination Techniques-Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Machine Vision Software, Machine Vision Automation, Integration of Machine Vision Components	
4		**Digital Image Processing for Machine Vision Applications**	10
		Preprocessing., Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold-Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis	
5		**Motion Analysis**	**4**
		Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking	
6		**Emerging Trends in Machine Vision**	**5**
	6.1	History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,	
	6.2	Applications in Machine/ Computer Vision: Face detection, face recognition, eigen faces, car on roads	

Textbooks:	
1.	Sheila Anand and L.Priya , “A Guide for Machine Vision in Quality Control”, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2.	Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson
3.	Carsten Stegar, Markus Ulrich, and Christian Wiedemann , “Machine Vision Algorithms and Applications”,Second completely Revised and Enlarged Edition

Draft Copy

4.	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision”, Second Edition, Cengage Learning.
References:	
1.	Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, SaqibHakak and Thippa Reddy Gadekallu ,”Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches, Fundamentals, technologies and applications” , IET COMPUTING SERIES 42
2	Joe Minichino Joseph Howse ,”Learning OpenCV 3 Computer Vision with Python”, Second Edition, Packt Publishing Ltd.
3.	Alexander Hornberg,, “ Handbook of Machine and Computer Vision The Guide for Developers and Users,

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://nptel.ac.in/courses/108103174
2	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
3	https://www.udacity.com/course/introduction-to-computer-vision--ud810
4	https://onlinecourses.nptel.ac.in/noc21_ee23/preview

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Course Code	Course Title	Credit
CSDC7012	**Cyber Security**	**3**

Prerequisite: Computer Networks, Databases

Course Objectives:

1	To understand the need for Cyber Security Awareness.
2	To understand the Flow and Methodology of an attack
3	To learn and explore various Static and Web vulnerability analysis tools
4	To understand the various IPR, Privacy and Security compliances

Course Outcomes:

1	Understand the need of Cyber Security and awareness of existing law infrastructure
2	Illustrate the various tools and techniques used by attackers to launch their attacks
3	Appraise various mechanisms of conducting system vulnerability analysis
4	Discuss various web application vulnerability scanning techniques
5	Identify the various network defense methodologies
6	Describe the various Privacy and standard compliances

Module		Content	Hrs
1		**Introduction to Cyber Crime and Attack Psychology**	**7**
	1.1	**Cyber Crime:** Need for Cyber Security, Cybercrime definition, Types of Cybercrime. Classifications of cybercrime, Hackers, Crackers and cyber criminals Indian IT ACT 2008 and its amendments.	
	1.2	**Attack Psychology:** How cyber criminals plan the attacks, Social Engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Attacks on Mobile.	
2		**Threat and Vulnerability Landscape**	**7**
		Goals of Security, Vulnerability vs Threat, What is Privacy, Anonymity and pseudonymity, The Vulnerability Landscape, Threat Modeling and risk Assessment, The Zero Trust model, Spyware, Adware, Scareware , Browser Hijacking, Phishing vs Vishing vs SMShing, Doxing and Spamming,Social Engineering attack.	
3		**System Vulnerability Scanning and Network Reconnaissance**	**7**

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		Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Phishing, Identity Theft (ID Theft),network information gathering, vulnerability scanning, Open Port Identification, Banner Grabbing Techniques, Vulnerability probing.	
4		**Web Application Security**	**8**
		OWASP, Web Security Considerations, Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security, OAuth 2.0	
5		**Network Security and Defense Tools**	**6**
		Network security: Cyber Hygine, Firewalls vs Packet Filters, Stateless vs Statefull Firewalls, Intrusion Detection System and its types, Honeypots, Demilitarized Zones, Network Address Translation (NAT), Port Forwarding. Virtual Private Networks, Email Security(GPG Encryption), Registry Settings for Mobile Devices	
6		**Information Security Privacy and Standard Compliances**	**4**
		HIPPA, FISMA, PCI DSS, GDPR, Intellectual Property Aspect of Cyber Law, Creative Commons Library, Data Protection Laws in India.	

Textbooks:	
1	William Stallings, Computer Security Principles and Practice, , Sixth Edition, Pearson Education
2	Charles P. Pfleeger Security in Computing, , Fifth Edition, Pearson Education
3	The Complete Cyber Security Course -Volume 1- Nathan House
4	Eric Cole, Network Security Bible, Second Edition, Wiley
References:	
1	Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2	The Information technology Act, 2000; Bare Act- Professional Book Publishers,
3	Michael Gregg, “Build your own Security Lab”, Wiley India
4	Dieter Gollman, “Computer Security”, Third Edition, Wiley
Digital References:	
Virtual Penetration Testing Labs- https://pentesterlab.com	
OWASP- https://owasp.org/	
DVWA- https://dvwa.co.uk	
FISMA - https://csrc.nist.gov/projects/risk-management/fisma-background	
PCI DS https://www.itgovernance.eu/blog/en/a-guide-to-the-4-pci-dss-compliance-levels	

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Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of total six questions.

2 All question carries equal marks

3 Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4 Only Four question need to be solved.

5 In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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Course Code	Course Name	Credit
CSDC7013	**Natural Language Processing**	**03**

Pre-requisite: Theory of Computer Science, System Programming &Compiler Construction

Course Objectives: The course aims

1	To define natural language processing and to learn various stages of natural language processing.
2	To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics &Discourse analysis.
3	To design and implement various language models and POS tagging techniques.
4	To design and learn NLP applications such as Information Extraction, Question answering.
5	To design and implement applications based on natural language processing.

Course Outcomes: Students will be able

1	To describe the field of natural language processing.
2	To design language model for word level analysis for text processing.
3	To design various POS tagging techniques and parsers.
4	To design, implement and test algorithms for semantic and pragmatic analysis.
5	To formulate the discourse segmentation and anaphora resolution.
6	To apply NLP techniques to design real world NLP applications.

Module		Detailed Content	Hours
1	1.1	**Introduction to NLP**	3
		Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP;Ambiguities and its types in English and Indian Regional Llanguages; Challenges of NLP;Applications of NLP	
	1.2	**Self-Learning topics:** Variety types of tools for regional languages pre-processing and other functionalities	
2	2.1	**Word Level Analysis**	9
		Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer);Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open	

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		versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace Smoothing, Good-Turing Discounting;	
	2.2	**Self-Learning topics:** Noisy channel models, various edit distance, Advance Issues in Language Modelling	
3	3.1	**Syntax analysis**	10
		Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF);Parsers: Top down and Bottom up; Modelling constituency; Bottom Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; Top Down Parser: Early Parser, Predictive Parser	
	3.2	**Self-Learning topics:** Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks	
4	4.1	**Semantic Analysis**	7
		Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach(Lesk's Algorithm), Supervised (Naïve Bayes, Decision List),Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)	
	4.2	**Self-Learning topics:** Dictionaries for regional languages, Distributional Semantics, Topic Models	
5	5.1	**Pragmatic & Discourse Processing**	5
		Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs and Cantering Algorithm	
	5.2	**Self-Learning topics:** Discourse segmentation, Conference resolution	
6	6.1	**Applications of NLP**	5
		Case studies on (preferable in regional language):Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system	
	6.2	**Self-Learning topics:** Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.	

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Textbooks:

1	Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

References:

1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications:

	from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
5	Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O'Reilly Media, 2009.

Digital References :	
1	http://www.cse.iitb.ac.in/~cs626-449
2	http://cse24-iiith.virtual-labs.ac.in/#
3.	https://nptel.ac.in/courses/106105158

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

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Course Code	Course Name	Credit
CSDC7021	**Virtual and Augmented Reality**	**04**

Prerequisite: Computer Graphics

Course Objectives: The course aims:

1	To understand the need and significance of Virtual Reality.
2	To explore the concepts of Virtual reality and develop 3D virtual environments.
3	To understand the technical and engineering aspects of virtual reality systems.
4	To analyze various techniques for applying virtual reality.
5	To provide a foundation to the fast growing field of AR and make the students aware of the various AR devices.

Course Outcomes: Learners will be able to

1:	Describe how VR systems work and list the applications of VR
2:	Elaborate geometric presentationof the virtual world and its operations.
3:	Explain the concepts of motion and tracking in VR systems.
4:	Design and implementation of the hardware that enables VR systems tobe built.
5:	Describe how AR systems work and analyze the hardware requirement of AR
6:	Analyze and understand the working of various state of the art AR devices.

Module		**Detailed Content**	**Hours**
1		**Introduction to Virtual Reality**	5
		What is virtual reality? ,The beginnings of VR , VR paradigms , Collaboration, Virtual reality systems, Representation ,User interaction	
2		**The Geometry of Virtual Worlds**	6
		Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations	
3		**Motion in Real and Virtual Worlds**	6
		Velocities and Accelerations , The Vestibular System , Physics in the Virtual World , Mismatched Motion and Vection	
4		**Applying Virtual Reality**	7
		Virtual reality: the medium, Form and genre, What makes an application a good candidate for VR, Promising application fields, Demonstrated benefits of virtual reality , More recent trends in virtual reality application development, A framework for VR application development	
5		**Augmented Reality**	8
		Terminology, Simple augmented reality, Augmented reality as an emerging technology, Augmented reality applications, Marker detection, Marker pose, Marker types and identification: Template markers, 2D bar-code markers, Imperceptible markers: Image markers, Infrared markers, Miniature markers, Discussion on marker use, General marker detection application	
6		**AR Development & Applications**	

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		User interfaces, Avoiding physical contacts , Practical experiences with head-mounted displays , Authoring and dynamic content ,AR applications and future visions, How to design an AR application ,Technology adoption and acceptance , Where to use augmented reality	

Textbooks:	
1	Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2	Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002
3	Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig,William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4	Theory and applications of marker-based augmented reality SanniSiltanen
References:	
1	AR Game Development‖, 1st Edition,Allan Fowler, A press Publications, 2018, ISBN 978-1484236178
2	Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
3	Learning Virtual Reality, Tony Parisi,O’Reilly Media, Inc., 2015, ISBN- 9781491922835

Digital Useful Links	
1	https://freevideolectures.com/course/3693/virtual-reality
2	https://www.vrlabacademy.com/
3	https://arvr.google.com/ar/
4	https://konterball.com/

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

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Course Code:	Course Title	Credit
CSDC7022	**Blockchain**	**3**

Prerequisite: Cryptography and System Security	
Course Objectives:	
1	Understand blockchain platforms and its terminologies.
2	Understand the use of cryptography required for blockchain.
3	Understand smart contracts, wallets, and consensus protocols.
4	Design and develop blockchain applications
Course Outcomes:	
1	Explain blockchain concepts.
2	Apply cryptographic hash required for blockchain.
3	Apply the concepts of smart contracts for an application.
4	Design a public blockchain using Ethereum.
5	Design a private blockchain using Hyperledger.
6	Use different types of tools for blockchain applications.

Module		Content	Hrs
1		**Introduction to Blockchain**	**6**
	1.1	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees	
	1.2	Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	
2		**Cryptocurrency**	**6**
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem	
	2.2	Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, Mining difficulty, Mining pool and its methods	
3		**Programming for Blockchain**	**8**
	3.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts	
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling	
	3.3	Case Study – Voting Contract App, Preparing for smart contract development	

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4		**Public Blockchain**	**8**
		Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum	
		Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure	
5		**Private Blockchain**	**8**
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies	
	5.3	Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger	
6		**Tools and Applications of Blockchain**	**3**
		Corda, Ripple, Quorum and other Emerging Blockchain Platforms, Blockchain in DeFi: Case Study on any of the Blockchain Platforms.	

Textbooks:	
1	Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2	Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O’reilly.
3	Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing
References:	
1	Blockchain for Beginners, Yathish R and Tejaswini N, SPD
2	Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
3	Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Assessment:
Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.
End Semester Theory Examination:

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1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mention in the syllabus.

Digital Useful Links	
1	Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2	Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
3	https://www.hyperledger.org/use/fabric
4	NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview

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Course Code	**Course Name**	**Credit**
CSDC7023	**Information Retrieval**	**03**

Prerequisite: Data structures and algorithms	
Course Objectives: The course aims students :	
1	To learn the fundamentals of Information Retrieval
2	To analyze various Information retrieval modeling techniques
3	To understand query processing and its applications
4	To explore the various indexing and scoring techniques
5	To assess the various evaluation methods
6	To analyze various information retrieval for real world application
Course Outcomes: Learner will be able to: -	
1	Define and describe the basic concepts of the Information retrieval system.
2	Design the various modeling techniques for information retrieval systems.
3	Understand the query structure and various query operations
4	Analyzing the indexing and scoring operation in information retrieval systems
5	Perform the evaluation of information retrieval systems
6	Analyze various information retrieval for real world application

Module		**Detailed Content**	**Hours**
1		**Introduction to Information Retrieval**	4
	1.1	Introduction to Information Retrieval, Basic Concepts, Information Versus Data, Trends and research issues in information retrieval.	
	1.2	The retrieval process, Information retrieval in the library, web and digital libraries.	
2		**Modeling in Information Retrieval**	8
	2.1	Taxonomy of Information Retrieval models, Classic Information Retrieval, Alternate set: Theoretical model, Alternative Algebraic models, Alternative Probabilistic models	
	2.2	Structured text Retrieval models, Models for browsing	
3		**Query and Operations in Information Retrieval**	8
	3.1	Query structures, Keyboard based querying, Pattern matching, Structured queries	
	3.2	User relevance feedback, Automatic local analysis, Automatic global analysis	
4		**Indexing and Scoring in Information Systems**	8
	4.1	Introduction, Inverted Files, Other Indices for Text, Boolean queries and Introduction to Sequential searching	

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	4.2	Scoring, term weighting and the vector space model, Parametric and zone indexes, Weighted zone scoring, Learning weights, The optimal weight, Term frequency and weighting, Inverse document frequency, Tf-idf weighting. The vector space model for scoring, Queries as vectors, Computing vector scores, Efficient scoring and ranking, Inexact top K document retrieval	
5		**Evaluation of Information Retrieval Systems**	6
	5.1	Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing and justifying the concept of relevance	
	5.2	System quality and user utility, System issues, Refining a deployed system	
6.		**Applications of Information Retrieval Systems**	5
	6.1.	Introduction to Multimedia Information Retrieval	
	6.2	Introduction to Distributed Information Retrieval	

Textbooks:	
1	Modern information retrieval, Baeza-Yates, R. and Ribeiro-Neto, B., 1999. ACM press.
2	Introduction to Information Retrieval By Christopher D. Manning and PrabhakarRaghavan, Cambridge University Press
3	Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
References:	
1	Storage Network Management and Retrieval, VaishaliKhairnar
2	Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman
3	Natural Language Processing and Information Retrieval by Tanveer Siddiqui, U.S Tiwarey

Useful Digital Links	
1	https://web.stanford.edu/class/cs276/
2	https://www.coursera.org/learn/text-retrieval

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

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Lab Code	Lab Name	Credit
CSL70011	**Machine Learning Lab**	**1**

Prerequisite: Data Structures, Analysis of Algorithms

Lab Objectives:

1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.

Lab Outcomes: At the end of the course, the students will be able to

1	To implement an appropriate machine learning model for the given application.
2	To implement ensemble techniques to combine predictions from different models.
3	To implement the dimensionality reduction techniques.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	To implement Linear Regression.
2	To implement Logistic Regression.
3	To implement Ensemble learning (bagging/boosting)
4	To implement multivariate Linear Regression.
5	To implement SVM
6	To implement PCA/SVD/LDA
7	To implement Graph Based Clustering
8	To implement DB Scan
9	To implement CART
10	To implement LDA

Term Work:

1	Term work should consist of 6 experiments.
2	Journal must include one mini project/case study on any machine learning application.
3	The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments & Assignments: 15-marks, Attendance: 05-marks, mini project: 05-marks)

Oral & Practical exam.

Based on the entire syllabus **CSC7011** Machine Learning **and CSL7011**: Machine Learning Lab

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Lab Code	Lab Name	Credit
CSL7012	**Big Data Analytics Lab**	**1**

Prerequisite: C Programming Language.

Lab Objectives: Students will be able to

1	Solve Big Data problems using Map Reduce Technique and apply to various algorithms.
2	Identify various types of NoSQL databases and execute NOSQL commands
3	Understand implementation of various analytic techniques using Hive/PIG/R/Tableau, etc.
4	Apply streaming analytics to real time applications.

Lab Outcomes:

1	To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
2	To implement algorithms that uses Map Reduce to apply on structured and unstructured data
3	To perform hands-on NoSql databases such as Cassandra, HadoopHbase, MongoDB, etc.
4	To implement various data streams algorithms.
5	To develop and analyze the social network graphs with data visualization techniques.

Suggested List of Experiments

(Select a case study and perform the experiments 1 to 8.).

Star (*) marked experiments are compulsory.

Sr. No.	**Name of the Experiment**
1*	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation. b. To execute basic commands of Hadoop eco system componentSqoop.
3*	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands
4	Experiment on Hadoop Map-Reduce: -Write a program to implement a word count program using MapReduce.
5	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc
6	Create HIVE Database and Descriptive analytics-basic statistics.
7*	Data Stream Algorithms (any one): - Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language
8	Social Network Analysis using R (for example: Community Detection Algorithm)
9	Data Visualization using Hive/PIG/R/Tableau/.
10	Exploratory Data Analysis using Spark/ Pyspark.

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11*	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). - Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. - Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) SpatioTemporal DataAnalytics

Useful Links:	
1	https://www.coursera.org/learn/hadoop#syllabus
2	https://www.coursera.org/learn/introduction-mongodb#syllabus
3	https://www.coursera.org/learn/data-visualization-tableau?specialization=data-visualization#syllabus
4	https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop#syllabus

Term Work:	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of and CSC702 : Big Data Analytics and CSL702 Big Data Analytics Lab

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Lab Code	**Lab Name**	**Credit**
CSDL7011	**Machine Vision Lab**	**1**

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives:	
1	To perform basic image processing operations
2	To explore different preprocessing technique
3	To develop application related to Machine vision
4	To detect and recognize objects
Lab Outcomes:	
1	Students will be able to read image and video file, perform different processing
2	Students will be able to do edge detection ,depth estimation
3	Students will be able to choose appropriate algo for segmentation
4	Students will be able to implement object detection technique

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr.No.	**Name of the Experiment**
1	**Handling Files, Cameras, and GUIs** Basic I/O scripts ,Reading/writing an image file ,Converting between an image and raw bytes ,Accessing image data with numpy.array ,Reading/writing a video file ,Capturing camera frames, Displaying images in a window, Displaying camera frames in a window
2	**Processing Images** with OpenCV 3 Converting between different color spaces, The Fourier Transform, High pass filter, Low pass filter,
3	**Edge detection** with Canny, Contour detection, Contours – bounding box, minimum area rectangle, and minimum enclosing circle ,Contours – convex contours and the Douglas-Peucker algorithm ,Line and circle detection
4	**Depth Estimation** Capturing frames from a depth camera Creating a mask from a disparity map Masking a copy operation Depth estimation with a normal camera
5	**Object segmentation** using the Watershed and GrabCut algorithms Example of foreground detection with GrabCut Image segmentation with the Watershed algorithm
6	**Detecting and Recognizing Faces** Conceptualizing Haar cascades Getting Haar cascade data Using OpenCV to perform face detection Performing face detection on a still image
7	**Performing face detection on video** Performing face recognition Generating the data for face recognition Recognizing faces Preparing the training data Loading the data and recognizing faces

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	Performing an Eigenfaces recognition
8	**Retrieving Images and Searching** Using Image Descriptors , Feature detection algorithms, Defining features Detecting features – corners Feature extraction and description using DoG and SIFT Anatomy of a keypoint
9	**Detecting and Recognizing Objects** Object detection and recognition techniques HOG descriptors The scale issue The location issue Non-maximum (or non-maxima) suppression Support vector machines People detection
10	**Creating and training an object detector** Bag-of-words BOW in computer vision Detecting cars in a scene

Reference &Useful Links:	
1	Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
2	http://iitk.ac.in/ee/computer-vision-lab
3	https://nptel.ac.in/courses/108103174
4	https://docs.opencv.org/3.4/d9/df8/tutorial_root.html

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
CSDL7012	**Cyber Security Lab**	**1**

Prerequisite: Computer Network

Lab Objectives:

1	To study and implement the flow and methodology of an attack
2	To explore various static and web vulnerability analysis tools
3	To study and implement the various Privacy and Security compliances

Lab Outcomes: At the end of the course, the students will be able to

1	Demonstrate the concept of various Privacy and standard compliances
2	Apply various tools for conducting system vulnerability analysis
3	Understand the various web application vulnerability scanning techniques
4	Apply the various network defense techniques
5	Demonstrate the concept of various techniques used by attackers to launch their attacks

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Study and implement phishing using website cloning. **Recommended Tool:** HTTrack Website Copier.
2	Static Code Analysis using open source tools. **Recommended Tool:** Flawfinder Python Distribution
3	Web Application Vulnerability Scanning and Auditing using open source tools. **Recommended Tools:** Nikto / Wapiti / Burpsuite (Kali Linux/ Windows)
4	Study and exploit database flaws and vulnerabilities using SQL Injection Attack. **Recommended Tool:** SQLMap (Kali Linux / Windows)
5	Study and Implement Packet Sniffing using Open Source Tools. **Recommended Tools:** Wireshark, TCP Dump
6	Study and implement Session Hijacking / Man in the Middle (MiTM) attack in a controlled virtual environment. **Recommended Tools:** Ettercap / Bettercap
7	Penetration Testing and Vulnerability Exploitation **Recommended Tool:** Metasploit (Kali Linux)
8	Study and Implement Cross Site Request Forgery in a controlled virtual environment. **Recommended Tool:** Damn Vulnerable Web App (DVWA) Web Server
9	Exploring Authentication, Authorization and Access Control (AAA) . **Recommended Tool:** Cisco Packet Tracer Student Edition, TACACS
10	Study and Implement Firewalls using IP tables. **Recommended Tool:** Kali Linux, IPTables, Oraclebox/VmWare
11	Study and Implement a Network Intrusion Detection System (NIDS) **Recommended Tool:** Kali Linux, SNORT, Oraclebox/VmWare
12	Study and Implement a Host Based Intrusion Detection System (HIDS) **Recommended Tool:** Kali Linux, OSSEC, Oraclebox/VmWare
13	Study and Implement Email Security using PGP Encryption **Recommended Tool:** GnuPG (Open Source Implementation of PGP)

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14	Study and Explore Malware/Keylogger Detection **Recommended Tool:** netstat, TCPView
15	Study and Explore the Creative Commons Library

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Cyber Security”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
CSDL7013	**Natural Language processing Lab**	**1**

Prerequisite: Java/Python	
Lab Objectives: The course aims	
1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques.
4	To understand various NLP Algorithms
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
6	To design and implement applications based on natural language processing
Lab Outcomes: Learners will be able	
1	Apply various text processing techniques.
2	Design language model for word level analysis.
3	Model linguistic phenomena with formal grammar.
4	Design, implement and analyze NLP algorithms.
5	To apply NLP techniques to design real world NLP applications such as machine translation, sentiment analysis, text summarization, information extraction, Question Answering system etc.
6	Implement proper experimental methodology for training and evaluating empirical NLP systems.

Suggested List of Experiments **(Select a case study and perform the experiments 1 to 8.)**.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various text preprocessing techniques for any given text : Tokenization and Filtration & Script Validation.
3	Apply various other text preprocessing techniques for any given text : Stop Word Removal, Lemmatization / Stemming.
4	Perform morphological analysis and word generation for any given text.
5	Implement N-Gram model for the given text input.
6	Study the different POS taggers and Perform POS tagging on the given text.
7	Perform Chunking for the given text input.
8	Implement Named Entity Recognizer for the given text input.

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9	Implement Text Similarity Recognizer for the chosen text documents.
10	Exploratory data analysis of a given text (Word Cloud)
11	Mini Project Report: For any one chosen real world NLP application.
13	Implementation and Presentation of Mini Project
14	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]

Term Work:	
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various text preprocessing techniques for any given text: Tokenization and Filtration & Script Validation.
3	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming.

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Lab Code	Lab Name	Credit
CSDL7021	**Augmented and Virtual Reality Lab**	**1**

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives:	
1	To perform installation of Unity
2	To explore working of VR Gadget
3	To develop scene VR application
4	To track objects in virtual environment
Lab Outcomes: Learners will be able to	
1	Setup VR development environment
2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
3	Develop VR scene and place object
4	Work with Augmented Faces features.

Suggested Experiments: Students are required to complete at least 6 experiments.	
Sr. No.	**Name of the Experiment**
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.
5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using vr controller.
6	Develop a simple UI(User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene .
7	Place a three-dimensional ARCore pawn on detected AR plane surfaces
8	Using the Augmented Faces feature in your own apps**.**

Term Work:	
1	Term work should consist of 6 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
CSDL7022	**Blockchain Lab**	**1**

Prerequisite: Cryptography and Network Security	
Lab Objectives:	
1	To explore Blockchain concepts.
2	To implement public and private Blockchain.
3	To create applications using Blockchain.
Lab Outcomes: At the end of the course, the students will be able to	
1	Creating Cryptographic hash using merkle tree.
2	Design Smart Contract using Solidity.
3	Implementing ethereum blockchain using Geth.
4	Demonstrate the concept of blockchain in real world application.

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Cryptography in Blockchain, Merkle root tree hash
2	Creating Smart Contract using Solidity and Remix IDE.
3	Creating Transactions using Solidity and Remix IDE
4	Embedding wallet and transaction using Solidity
5	Blockchain platform ethereum using Geth.
6	Blockchain platform Ganache.
7	Case Study on Hyperledger
8	Case Study on Other Blockchain platforms.
9	Creating a blockchain Application

Term Work:	
1	Term work should consist of 8 experiments and one mini project.
2	Journal must include at least 2 assignments on content of theory and practical of "Blockchain Lab"
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
CSDL7023	**Information Retrieval Lab**	**1**

Prerequisite: Java, Python	
Lab Objectives:	
1	To understand the formation of queries.
2	To implement the various modeling techniques for IR.
3	To execute query expansion techniques.
4	To evaluate Information retrieval systems.
Lab Outcomes: Students will be able :-	
1	To frame queries for information retrieval
2	To implement modeling techniques
3	To perform query expansion techniques
4	To demonstrate evaluation techniques for IR

Suggested Experiments: Students are required to perform any **5 experiments** from the suggested list along with **a case study** (* indicates compulsory experiment)	
Sr. No.	**Name of the Experiment**
1	To understand the query structure and execute various structured queries
2	To implement any IR modeling technique
3	To implement Pattern matching method used for IR
4	To execute query expansion technique (Local/Global)
5	To design inverted indices for any information retrieval model
6	To implement tf-id weighting
7	To evaluate the system/application under study
8*	To understand the Case Study and generate a report for the same

Term Work:	
1	Term work should consist of **5 experiments and 1 case study**
2	Journal must include **at least 2 assignments**.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total: **25 Marks (Experiments: 10-marks, Case study - 5 marks Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

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Course Code	Course Name	Credit
CSP701	**Major Project 1**	**03**

Course Objectives:	
The project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.	
Course Outcomes: Learner will able	
1	To develop the understanding of the problem domain through extensive review of literature.
2	To Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and environment..
5	To develop clarity of presentation based on communication, teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines:

1. Project Topic Selection and Allocation:

- Project topic selection Process to be defined and followed:
    - Project orientation can be given at the end of sixth semester.
    - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
    - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
    - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.

- Topics can be finalized with respect to following criterion:
    - **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
    - **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
    - Students should not repeat work done previously (work done in the last three years).

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- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
  - Analysis/Framework/ Algorithm
  - Design details
  - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
  - Details of Database or details about input to systems or selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Set up
- Implementation Plan for Next Semester
  - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- References

Desirable

Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

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3. Term Work:

Distribution of marks for term work shall be done based on following:

- Weekly Log Report
- Project Work Contribution
- Project Report (Spiral Bound) (both side print)
- Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral and Practical:

Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as follows:

- Quality of problem selected
- Clarity of problem definition and feasibility of problem solution
- Relevance to the specialization / industrial trends
- Originality
- Clarity of objective and scope
- Quality of analysis and design
- Quality of written and oral presentation
- Individual as well as team work

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Course Code:	Course Title	Credit
CSC801	**Distributed Computing**	**3**

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To provide students with contemporary knowledge in distributed systems.
2	To explore the various methods used for communication in distributed systems.
3	To provide skills to measure the performance of distributed synchronization algorithms.
4	To provide knowledge of resource management, and process management including process migration.
5	To learn issues involved in replication, consistency, and file management.
6	To equip students with skills to analyze and design distributed applications.
Course Outcomes: At the end of the course students will be able to	
1	Demonstrate the knowledge of basic elements and concepts related to distributed system technologies.
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object-based middleware.
3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
4	Demonstrate the concepts of Resource and Process management.
5	Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
6	Apply the knowledge of Distributed File systems in building large-scale distributed applications.

Module	Content	Hrs
1	**Introduction to Distributed Systems**	**4**
1.1	Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS.	
1.2	Middleware: Models of middleware, Services offered by middleware.	
2	**Communication**	**4**
2.1	Interprocess communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI).	
2.2	Message-Oriented Communication, Stream Oriented Communication, Group Communication.	
3	**Synchronization**	**10**
3.1	Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms	
3.2	Distributed Mutual Exclusion, Requirements of Mutual Exclusion Algorithms and Performance measures. Non- token Based Algorithms: Lamport, Ricart–Agrawala‘s and Maekawa‘s Algorithms; Token-based Algorithms: Suzuki-Kasami‘s Broadcast Algorithms and Raymond‘s Tree-based Algorithm; and Comparative Performance Analysis.	

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3.3	Deadlock: Introduction, Deadlock Detection: Centralized approach, Chandy - Misra_Hass Algorithm.	
4	**Resource and Process Management**	**7**
4.1	Desirable Features of Global Scheduling algorithm, Task assignment approach, Load balancing approach and load sharing approach.	
4.2	Introduction to Process Management, Process Migration, Code Migration.	
5	**Replication, Consistency and Fault Tolerance**	
5.1	Distributed Shared Memory: Architecture, design issues.	8
5.2	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management.	
5.3	Fault Tolerance: Introduction, Process resilience, Recovery.	
6	**Distributed File Systems**	**6**
6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Network File System (NFS).	
6.2	Designing Distributed Systems: Google Case Study.	

Textbooks:	
1	Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2	Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education.
3	Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
References:	
1	M. L. Liu, —Distributed Computing Principles and Applications‖, Pearson Addison Wesley, 2004
2	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

Useful Links	
1	https://nptel.ac.in/courses/106106107
2	https://nptel.ac.in/courses/106106168
3	http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
4	https://nptel.ac.in/courses/106104182

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Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. The duration of each test shall be one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

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Course Code:	Course Title	Credit
CSDC8011	**Deep Learning**	**3**

Prerequisite: Basic mathematics and Statistical concepts, Linear algebra, Machine Learning	
Course Objectives:	
1	To learn the fundamentals of Neural Network.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning.
Course Outcomes:	
1	Gain basic knowledge of Neural Networks.
2	Acquire in depth understanding of training Deep Neural Networks.
3	Design appropriate DNN model for supervised, unsupervised and sequence learning applications.
4	Gain familiarity with recent trends and applications of Deep Learning.

Module		Content	39Hrs
1		**Fundamentals of Neural Network**	**4**
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes	
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	
2		**Training, Optimization and Regularization of Deep Neural Network**	**10**
	2.1	**Training Feedforward DNN** Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	
	2.2	**Optimization** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	**Regularization** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output	
3		**Autoencoders: Unsupervised Learning**	**6**
	3.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	

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	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
	3.3	Application of Autoencoders: Image Compression	
4		**Convolutional Neural Networks (CNN): Supervised Learning**	**7**
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function	
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture	
5		**Recurrent Neural Networks (RNN)**	**8**
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	5.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	
6		**Recent Trends and Applications**	**4**
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Generation, DeepFake	

Textbooks:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning”, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, “Deep Learning Methods and Applications”, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada “Introduction to Artificial Neural Systems”, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. “Algorithms for Optimization”, MIt Press.
References:	
1	Buduma, N. and Locascio, N., “Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
2	François Chollet. “Deep learning with Python “(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. “Deep Learning Cookbook”, O’REILLY, SPD Publishers, Delhi.
4	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5	S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India

Assessment:	
Internal Assessment:	
The assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Question 1 and question 6 will have questions from all modules. Remaining 4 questions will be based on the remaining 4 modules.
4	Only four questions need to be solved.

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5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/

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Course Code:	Course Title	Credit
CSDC8012	**Digital Forensics**	**3**

Prerequisite: Computer Network, Cryptography and System Security	
Course Objectives:	
1	To discuss the need and process of digital forensics and Incident Response Methodology.
2	To explore the procedures for identification, preservation, and acquisition of digital evidence.
3	To explore techniques and tools used in digital forensics for Operating system and malware investigation .
4	To explore techniques and tools used for Mobile forensics and browser, email forensics
Course Outcomes:	
1	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
2	Describe the process of collection, analysis and recovery of the digital evidence.
3	Explore various tools to analyze malwares and acquired images of RAM/hard drive.
4	Acquire adequate perspectives of digital forensic investigation in mobile devices
5	Analyze the source and content authentication of emails and browsers.
6	Produce unambiguous investigation reports which offer valid conclusions.

Module		Content	Hrs
1		**Introduction to Digital Forensics**	**6**
	1.1	Digital ForensicsDefination, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics	
	1.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
2		**Digital Evidence, Forensics Duplication and Digital Evidence Acquisition**	**9**
	2.1	Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody	
	2.2	Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,.	
	2.3	Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition	
3		**Forensics Investigation**	**4**
	3.1	Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	
	3.2	Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and	

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		Techniques	
4		**Windows and Unix Forensics Investigation**	**8**
	4.1	Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	
	4.2	Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships	
5		**Mobile Forensics**	**8**
	5.1	Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis	
	5.2	GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map.	
	5.3	SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.	
6		**Browser, Email Forensic & Forensic Investigation Reporting**	**4**
	6.1	Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	
	6.2	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	

Textbooks:	
1	Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2	Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019
3	Xiaodong Lin, “Introductory Computer Forensics: A Hands-on Practical Approach”, Springer Nature, 2018

Suggested MOOC Course Links	
1	Course on “Ethical Hacking” https://nptel.ac.in/courses/106/105/106105217/
2	Course on “Digital Forensics” https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
4	Course on “Penetration Testing, Incident Responses and Forensics” https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

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Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise a total of six questions.

2 All question carries equal marks

3 Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4 Only Four questions need to be solved.

5 In question paper weightage of each module will be proportional to the number of respective lecture hours as mention in the syllabus.

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Course Code	Course Name	Credit
CSDC8013	**Applied Data Science**	**03**

Prerequisite: Machine Learning, Data Structures & Algorithms	
Course Objectives:	
1	To introduce students to the basic concepts of data science.
2	To acquire an in-depth understanding of data exploration and data visualization.
3	To be familiar with various anomaly detection techniques.
4	To understand the data science techniques for different applications.
Course Outcomes:	
1	To gain fundamental knowledge of the data science process.
2	To apply data exploration and visualization techniques.
3	To apply anomaly detection techniques.
4	To gain an in-depth understanding of time-series forecasting.
5	Apply different methodologies and evaluation strategies.
6	To apply data science techniques to real world applications.

Module		Detailed Content	Hours
1		**Introduction to Data Science**	2
	1.1	Introduction to Data Science, Data Science Process	
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples	
	1.3	Overview of Data Preparation, Modeling, Difference between data science and data analytics	
2		**Data Exploration**	8
	2.1	Types of data, Properties of data **Descriptive Statistics:** Univariate Exploration: Measure of Central Tendency, Measure of Spread, Symmetry, Skewness: Karl Pearson Coefficient of skewness, Bowley’s Coefficient, Kurtosis Multivariate Exploration: Central Data Point, Correlation, Different forms of correlation, Karl Pearson Correlation Coefficient for bivariate distribution	

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	2.2	**Inferential Statistics:** Overview of Various forms of distributions: Normal, Poisson, Test Hypothesis, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, ANOVA	
3		**Methodology and Data Visualization**	**06**
	3.1	**Methodology:** Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping	
	3.2	**Data Visualization** Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart Roadmap for Data Exploration	
	3.3	**Self-Learning Topics:** Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	
4		**Anomaly Detection**	**06**
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics	
	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE	
5		**Time Series Forecasting**	4
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition	
	5.2	Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	
	5.3	**Self-Learning Topics:** Evaluation parameters for Classification, regression and clustering.	
6		**Applications of Data Science**	4
		Predictive Modeling: House price prediction, Fraud Detection Clustering: Customer Segmentation Time series forecasting: Weather Forecasting Recommendation engines: Product recommendation	

Textbooks:	
1	Vijay Kotu, Bala Deshpande. "Data Science Concepts and Practice", Elsevier, M.K. Publishers.
2	Steven Skiena, "Data Science Design Manual", Springer International Publishing AG
3	Samir Madhavan. "Mastering Python for Data Science", PACKT Publishing
4	Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, "Comprehensive Statistical Methods", S.Chand Publications, New Delhi.

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References:

1	Jake VanderPlas. “Python Data Science Handbook”, O’reilly Publications.
2	Francesco Ricci, LiorRokach, BrachaShapira, Paul B. Kantor, “Recommender Systems Handbook”, Springer.
3	S.C. Gupta, V. K. Kapoor “Fundamentals of Mathematical Statistics”, S. Chand and Sons, New Delhi.
4	B. L. Agrawal. “Basic Statistics”, New Age Publications, Delhi.

Useful Links

1	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs69/preview

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4	Only Four questions need to be solved.

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Course Code:	Course Title	Credit
CSDC8021	**Optimization in Machine Learning**	**3**

Prerequisite: Engineering Mathematics, Algorithms and data structures

Course Objectives:

1. Understand, analyze and apply existing derivative based optimization algorithms
2. Analyze and apply stochastic methods in optimization
3. Analyze convex optimization for machine learning problems
4. Understand real life problems and apply evolutionary methods to optimize them

Course Outcomes:

1. To understand foundational optimization ideas including gradient descent, stochastic gradient methods
2. To apply convex optimization algorithm
3. To analyze and demonstrate several population methods in Evolutionary Computation
4. To apply advanced evolutionary algorithms such as particle swarm and ant colony optimization

Module		Content	Hrs
1		**Introduction and Background to Optimization Theory**	**4**
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization	
2		**Derivative based Optimization**	**10**
	2.1	The Basics of Optimization (univariate, bivariate and multivariate optimization), Convex Objective Functions	
	2.2	First-Order optimization Methods : Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum, Adagrad, RMSProp, learning rate optimization	
	2.3	Second order optimization: Newton method	
3		**Stochastic Methods**	**6**
		Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation	
4		**Convex Optimization**	**6**
		Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems,	

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		Geometric programming, Overview of Generalized inequality constraints and Vector optimization	
5		**Evolutionary Methods**	**8**
	5.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection,Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions	
	5.2	Canonical Genetic Algorithm, Binary Representations of Crossover and Mutation: Binary Representations, Control Parameters	
6		**Advance Evolutionary Methods**	**5**
	6.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures	
	6.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone, Simple Ant Colony Optimization, Ant System, Ant Colony System	

Textbooks:	
1	Mykel J. Kochenderfer, Tim A.Wheeler, Algorithms for Optimization, MIT Press (2019)
2	Andries P Engelbrecht, Computational Intelligence-An Introduction, Second-Edition, Wiley publication
3	Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, , Springer ,2020.
References:	
1	SuvritSra, Sebastian Nowozin, Stephen J. Wright, Optimization for Machine Learning, The MIT Press
2	Xin-She Yang Middlesex ,Optimization techniques and applications with examples, Wiley
3	A.E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer

Useful Links	
1	Convex optimization (NPTEL)
2	Constrained and Unconstrained optimization (NPTEL)
3	Machine-learning-model-performance (Coursera)
4	Deep-neural-network optimization (Coursera)

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Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All questions carry equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

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Course Code:	Course Title	Credit
CSDC8022	High Performance Computing	3

Prerequisite: Computer Architecture, Operating System, Cloud Computing	
Course Objectives: The objective of the course is to	
1	Introduce the fundamental concepts of high-performance computing (HPC) architecture and parallel computing.
2	Provide foundations for developing, analyzing, and implementing parallel algorithms using parallelization paradigms like MPI, OpenMP, OpenCL, and CUDA.
3	Introduce range of activities associated with HPC in Cloud
Course Outcomes: After learning the course, the students will be able to:	
1	Understand parallel and pipeline processing approaches
2	Design a parallel algorithm to solve computational problems and identify issues in parallel programming.
3	Analyze the performance of parallel computing systems for clusters in terms of execution time, total parallel overhead, speedup.
4	Develop efficient and high-performance parallel algorithms using OpenMP and message passing paradigm
5	Develop high-performance parallel programming using OpenCL and CUDA framework
6	Perform the range of activities associated with High Performance Computing in Cloud Computing

Module		Content	Hrs
1		**Introduction to Parallel Computing**	5
	1.1 1.2 1.3 1.4	Parallelism (What, Why, Applications), Levels of parallelism(instruction, transaction, task, thread, memory, function) **Classification Models:** Architectural Schemes(Flynn's, Shore's, Feng's, Handler's) **Memory Access:** Distributed Memory, Shared Memory, Hybrid Distributed Shared Memory **Parallel Architecture:** Pipeline Architecture: Arithmetic pipelines, Floating Point, Array Processor	
2		**Parallel Programming Platform and Algorithm Design**	11
	2.1 2.2	**Parallel Programming Platform:** Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines **Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.	
3		**Performance Measures**	3
		Performance Measures: Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks, The Karp Flatt Metric.	
4		**HPC Programming: OpenMP and MPI**	10

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		HPC Programming: OpenMP	
	4.1	Introduction: Threads, Share memory Architecture, Multi-core processors and Hyperthreading, Fork and join model.	
	4.2	OpenMP directives: #pragma omp parallel, Hello world with openMP, #pragma omp for, #pragma omp for schedule.Serial vs Parallel PI program.	
	4.3	Synchronisation: Introduction, Private vs Shared variables. Critical section, #pragma omp critical, #pragma omp atomic, #pragma omp barrier, #pragma omp reduction	
		HPC Programming: MPI	
	4.4	Introduction: Processes, Multiprocessor programming model, Distributed system programming model, Inter-process communication using message passing: Asynchronous and Synchronous	
	4.5	MPI Programming: Hello world problem, mpi_initMPI_sendMPI_Recv, Synchronisation: MPI_Barrier	
	4.6	Hybrid (MPI + OpenMP) programming, Hardware requirement, Threads inside Processes, Hybrid Matrix multiplication	
	4.7	Message passing vs Share memory communication: Advantages and disadvantage	
5		**Parallel programming using accelerators**	**4**
		An Overview of GPGPUs, Introduction to CUDA, Introduction to Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL.	
6		**High Performance Computing in the Cloud**	**4**
		Virtualization and Containerization, Parallel Computing Frameworks, Scaling, HPC in the Cloud Use Cases.	

Textbooks:	
1	AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar “Introduction to Parallel Computing”, 2nd edition, Addison Wesley, 2003.
2	Shane Cook, Morgan Kaufmann “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, 2012.
3	M. R. Bhujade “Parallel Computing”,2nd edition, New Age International Publishers, 2009.
4	Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture: Parallelism, Scalability, Programmability” McGraw Hill, Second Edition, 2010.
5	Georg Hager, Gerhard Wellein, Chapman “Introduction to High Performance Computing for Scientists and Engineers” Hall/CRC Computational Science Series, 2011.
References:	
1	Michael J. Quinn “Parallel Programming in C with MPI and OpenMPI” by, McGraw Hill Education, 2008.
2	Kai Hwang ,Zhiwei, “Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw-Hill Education, 1998.
3	Laurence T. Yang, Minyi Guo, “High-Performance Computing: Paradigm and Infrastructure”, by, Wiley, 2006.

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Useful Links	
1	https://nptel.ac.in/courses/112105293
2	https://archive.nptel.ac.in/courses/128/106/128106014/

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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Course Code	Course Name	Credit
CSDC8023	**Social Media Analytics**	**03**

Prerequisite: Graph Theory, Data Mining, Python/R programming

Course Objectives: The course aims:

1	Familiarize the learners with the concept of social media.
2	Familiarize the learners with the concept of social media analytics and understand its significance.
3	Enable the learners to develop skills required for analyzing the effectiveness of social media.
4	Familiarize the learners with different tools of social media analytics.
5	Familiarize the learner with different visualization techniques for Social media analytics.
6	Examine the ethical and legal implications of leveraging social media data.

Course Outcomes:

1	Understand the concept of Social media
2	Understand the concept of social media Analytics and its significance.
3	Learners will be able to analyze the effectiveness of social media
4	Learners will be able to use different Social media analytics tools effectively and efficiently.
5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
6	Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

Module	Detailed Content	Hours
1.	**Social Media Analytics: An Overview**	
	Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools	6
2.	**Social Network Structure, Measures & Visualization**	
	Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.	6
3.	**Social Media Text, Action & Hyperlink Analytics**	
	Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text	8

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	Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools	
4.	**Social Media Location & Search Engine Analytics**	
	Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools	6
5.	**Social Information Filtering**	
	Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	6
6.	**Social Media Analytics Applications and Privacy**	
	Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacy online.	7

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Textbooks:	
1.	Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
2.	Analyzing the Social Web 1st Edition by Jennifer Golbeck
3.	Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011
References:	
1.	Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2.	Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3.	Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6

Useful Links	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146
4	https://7layersanalytics.com/

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

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Lab Code	Lab Name	Credit
CSL801	**Distributed Computing Lab**	**1**

Prerequisite: Computer Networks and Operating Systems.

Lab Objectives:

1	To understand basic underlying concepts of forming distributed systems.
2	To learn the concept of clock Synchronization
3	To learn Election Algorithm.
4	To explore mutual exclusion algorithms and deadlock handling in the distributed system
5	To study resource allocation and management.
6	To understand the Distributed File System

Lab Outcomes: At the end of the course, the students will be able to

1	Develop test and debug usingMessage-Oriented Communication or RPC/RMI based client-server programs.
2	Implement techniques for clock synchronization.
3	Implement techniques for Election Algorithms.
4	Demonstrate mutual exclusion algorithms and deadlock handling.
5	Implement techniques of resource and process management.
6	Describe the concepts of distributed File Systems with some case studies.

Suggested List of Experiments

Sr. No.	**Title of Experiment**
1	Inter-process communication
2	Client/Server using RPC/RMI
3	Group Communication
4	Clock Synchronization algorithms
5	Election Algorithm.
6	Mutual Exclusion Algorithm
7	Deadlock Management in Distributed System
8	Load Balancing
9	Distributed shared Memory
10	Distributed File System (AFS/CODA)
11	Case Study: CORBA
12	Case Study: Android Stack

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Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of CSC801 and CSL801(Distributed Computing)
3	The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral and Practical exam	
Based on the entire syllabus of CSC801: Distributed Computing and CSL801: Distributed Computing Lab	

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Lab Code	Lab Name	Credit
CSDL8021	**Deep Learning Lab**	**1**

Prerequisite: Python Programming, Engineering Mathematics	
Lab Objectives:	
1	To implement basic neural network models for simulating logic gates.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised and sequence learning.
Lab Outcomes: At the end of the course, the students will be able to	
1	Implement basic neural network models to learn logic functions.
2	Design and train feedforward neural networks using various learning algorithms.
3	Build and train deep learning models such as Autoencoders, CNNs, RNN, LSTM etc.

Suggested List of Experiments	
1.	**Based on Module 1 (Any two) using Virtual Lab**
	1. Implement Mc-Culloch Pitts model for binary logic functions. 2. Implement Perceptron algorithm to simulate any logic gate. 3. Implement Multilayer Perceptron algorithm to simulate XOR gate. 4. To explore python libraries for deep learning e.g. Theano, TensorFlow etc.
2	**Module 2 (Any Two)**
	5. Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. Adam Learning GD 6. Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers. 7. Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function.
4.	**Module 3 (Any One)**
	8. Design the architecture and implement the autoencoder model for Image Compression. 9. Design the architecture and implement the autoencoder model for Image denoising.
5	**Module 4 (Any One)**
	10. Design and implement a CNN model for digit recognition application. 11. Design and implement a CNN model for image classification.
6	**Module 5 (Any One)**

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	12. Design and implement LSTM for Sentiment Analysis. 13. Design and implement GRU for classification on text data. 14. Design and implement RNN for classification of temporal data.

Term Work:	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)
Practical and Oral exam	
	Based on the entire syllabus of CSDC8011: Deep Learning and CSDL8011: Deep Learning Lab

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Lab Code	Lab Name	Credit
CSDL8022	**Digital Forensics Lab**	**1**

Prerequisite: Computer Network, Cryptography and System Security	
Lab Objectives:	
1	To demonstrate the procedures for identification, preservation, and acquisition of digital evidence.
2	To demonstrate techniques and tools used in digital forensics for operating systems and malware investigation.
3	To demonstrate tools formobile forensics and browser, email forensics
4	To explore scenario based crime forensics investigations.
Lab Outcomes: At the end of the course, the students will be able to	
1	Explore various forensics tools and use them to acquire, duplicate and analyze data and recover deleted data.
2	Implement penetration testing using forensics tools.
3	Explore various forensics tools and use them to acquire and analyze live and static data.
4	Verification of source and content authentication of emails and browsers.
5	Demonstrate Timeline Report Analysis using forensics tools.
6	Discuss real time crime forensics investigations scenarios.

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Analysis of forensic images using open source tools. ● FTK Imager ● Autopsy
2	Explore forensics tools in kali linux for acquiring, analyzing and duplicating data. ● dd ● dcfldd
3	Performing penetration testing using Metasploit - kali Linux.
4	Performing RAM Forensic to analyze memory images to find traces of an attack. ● Capturing RAM Using the DumpIt Tool ● Volatility tool
5	Network forensics using Network Miner.
6	Windows Recycle Bin Forensics
7	Data Carving using open source tools ● Foremost ● Scalpel ● Jpegcarver
8	USB Device Forensics using ● USBDeview ● USB Detective
9	Web Browser Forensics using DB Browser for SQLite
10	Generate a Timeline Report Using Autopsy
11	Email Analysis
12	Case Study

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Term Work:	
1	Term work should consist of 7 experiments covering all the modules and one case study.
2	Journal must include at least 2 assignments on content of theory and practical
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments & Case Study : 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSDC8012- Digital Forensics and CSDL8012- Digital Forensics Lab

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Lab Code	Lab Name	Credit
CSL8023	Applied Data Science Lab	1

Prerequisite: Engineering Mathematics, Machine Learning, Programming fundamentals	
Lab Objectives:	
1	To explore various stages in the data science lifecycle.
2	To understand data preparation, exploration and visualization techniques.
3	To model and evaluate different supervised/unsupervised learning techniques.
Lab Outcomes: At the end of the course, the students will be able to	
1	Apply various stages of the data science lifecycle for the selected case study.
2	Demonstrate data preparation, exploration and visualization techniques.
3	Implement and evaluate different supervised and unsupervised techniques.

Suggested List of Experiments
(Select a case study and perform the experiments 1 to 8.).

Star (*) marked experiments are compulsory.

Name of the Experiment

1. Explore the descriptive and inferential statistics on the given dataset.
2. Apply data cleaning techniques (e.g. Data Imputation).
3. Explore data visualization techniques.
4. Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)
5. Use SMOTE technique to generate synthetic data.(to solve the problem of class imbalance)
6. Outlier detection using distance based/density based method.
7. Implement time series forecasting.

Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study)

Suggested Case Studies:

1. Customer Segmentation
2. Fraud Detection
3. House Price prediction
4. Product Recommendation
5. Stock price prediction
6. Weather prediction

Suggested Assignment List

Assignments can be given on self learning topics or data deployment tools.

Term Work:	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)
Practical and Oral exam	
	Based on the entire syllabus of CSDC 8013: Applied Data Science and CSDL 8013: Applied Data Science Lab

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Lab Code	**Lab Name**	**Credit**
CSDL8021	**Optimization in Machine Learning**	**1**

Prerequisite: Algorithms and data structures	
Lab Objectives:	
1	To apply derivative based optimization techniques
2	To understand evolutionary optimization to a given machine learning problem.
3	To apply advanced evolutionary optimization
4	To design and analyze optimization problems for real world applications
Lab Outcomes: At the end of the course, the students will be able to	
1	To implement derivative based optimization techniques
2	To implement evolutionary optimization
3	To implement advanced evolutionary optimization
4	To apply efficient optimization algorithm for real world applications

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	To implement Gradient Descent algorithm
2	To implement the Stochastic Gradient Descent algorithm
3	To implement Newton method
4	To apply Genetic Algorithm for real world problem
5	To compare and implement different selection mechanism using genetic algorithm
6	To implement various mutation and crossover mechanisms
7	To implement Particles Swarm optimization
8	To implement Ant colony optimization

Term Work:	
1	Term work should consist of 6 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "**Optimization in Machine Learning**"
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments and assignments: 15-marks, Attendance Theory & Practical: 05-marks, Case study /Mini project: 05-marks)
Practical and Oral exam	
	Based on the entire syllabus of CSDC8021: Optimization in Machine Learning and CSDL8021: Optimization in Machine Learning

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Lab Code	Lab Name	Credit
CSDL8022	**High Performance Computing Lab**	**1**

Prerequisite: C Programming	
Lab Objectives: The objective of the course is to:	
1	Enable students to build the logic to parallelize the programming task.
2	Give insight about performance of parallel computing systems.
3	Provide hands-on experience on parallel programming platforms/frameworks
Lab Outcomes: After learning the course, the students will be able to:	
1	Perform Linux based commands on remote machine
2	Compare the performance of sequential algorithms with parallel algorithm in terms of execution time, speedup and throughput.
3	Implement parallel program using OpenMP libraryand analyze its performance
4	Implement parallel program using MPIplatform and analyze its performance
5	Implement parallel program using OpenCL framework and analyze its performance
6	Implement parallel program using CUDA framework and analyze its performance

Suggested Experiments: Students are required to complete at least 8 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	To analyse the Linux based computer systems using following commands: **a.** top , **b.**ps , **c.** kill, **d.** cat /proc/cpuinfo**e.**vmstat **Hardware/Software Requirement:** Linux Operating System
2*	To setup SSH passwordless logins for two or more Linux based machines and execute commands on a remote machine. **Hardware/Software Requirement:** Linux Operating System, Multi-core computer systems
3*	Write a program in C to multiply two matrices of size 10000 x 10000 each and find it's execution-time using "time" command. Try to run this program on two or more machines having different configurations and compare execution-times obtained in each run. Comment on which factors affect the performance of the program. **Hardware/Software Requirement:** Linux Operating System, gcc compiler,Multi-core computer systems
4*	Write a "Hello World" program using OpenMP library also display number of threads created during execution. **Hardware/Software Requirement:** Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
5*	Write a parallel program to calculate the value of PI/Area of Circle using OpenMP library. **Hardware/Software Requirement:** Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
6*	Write a parallel program to multiply two matrices using openMP library and compare

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	the execution time with its serial version. Also change the number of threads using omp_set_num_threads() function and analyse how thread count affects the execution time. **Hardware/Software Requirement:** Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
7*	Install MPICH library and write a "Hello World" program for the same. **Hardware/Software Requirement:** Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
8*	Write a parallel program to multiply two matrices using MPI library and compare the execution-time with it's OpenMP and serial version. **Hardware/Software Requirement:** Linux Operating System, MPICH, gcc, Multi-processor systems, or MPI Cluster.
9*	Install MPICH on two and more machines and create a MPI cluster. Execute MPI programs on this cluster and check the performance. **Hardware/Software Requirement:** Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
10*	Implement a program to demonstrate balancing workload on MPI platform. **Hardware/Software Requirement:** Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
11	Implement a parallel program to demonstrate the cube of N number within a set range using MPI/OpenMP/OpenCL/CUDA. **Hardware/Software Requirement:** Linux Operating System, MPICH, Multi-processor systems or MPI Cluster. A CUDA-capable GPU,A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
12	Implement DFT computation of vector using OpenCL/CUDA/ Parallel Matlab **Hardware/Software Requirement:** A CUDA-capable GPU,A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
13	Implement Two Vector addition using OpenCL/CUDA/ Parallel Matlab **Hardware/Software Requirement:** A CUDA-capable GPU, A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
14	Implement even-odd/Bucket /Radix /Shell sort using OpenCL/CUDA/ Parallel Matlab **Hardware/Software Requirement:** A CUDA-capable GPU, A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical and Oral Exam	
	Based on the entire syllabus of CSDC8022 : High Performance Computing and CSDL8022 High Performance Computing Lab

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Lab Code	Lab Name	Credit
CSDL8023	**Social Media Analytics Lab**	**1**

Prerequisite: Types of Graphs, Data Mining, Data Analytics	
Lab Objectives:	
1	To understand the fundamental concepts of social media networks.
2	To learn various social media analytics tools and evaluation matrices.
3	To collect and store social media data.
4	To analyze and visualize social media data
5	To design and develop social media analytics models.
6	To design and build a social media analytics application.
Lab Outcomes: The students will be able to	
1	Understand characteristics and types of social media networks.
2	Use social media analytics tools for business
3	Collect, monitor , store and track social media data
4	Analyze and visualize social media data from multiple platforms
5	Design and develop content and structure based social media analytics models.
6.	Design and implement social media analytics applications for business.

Suggested Experiments:	
Sr. No.	**Name of the Experiment**
1	Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/
2	Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing).
3	Data Cleaning and Storage- Preprocess, filter and store social media data for business (Using Python, MongoDB, R, etc).
4	Exploratory Data Analysis and visualizationof Social Media Data for business.
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis)
7	Develop a dashboard and reporting tool based on real time social media data.

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8	Design the creative content for promotion of your business on social media platform.
9	Analyze competitor activities using social media data.
10	Develop social media text analytics models for improving existing product/ service by analyzing customer’s reviews/comments.

Reference Books:	
1	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk
2	Learning Social Media Analytics with R,byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.
3	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
4	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
5	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	**Total 25 Marks** (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Practical and Oral Exam

Based on the entire syllabus of CSDC8023: **Social Media Analytics** and CSDL80223: **Social Media Analytics Lab**

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Course Code	Course Name	Credit
CSP801	**Major Project 2**	**06**

Course Objectives::	
The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.	
Course Outcomes: Student will able to	
1	Implement solutions for the selected problem by applying technical and professional skills.
2	Analyze impact of solutions in societal and environmental context for sustainable development.
3	Collaborate best practices along with effective use of modern tools.
4	Develop proficiency in oral and written communication with effective leadership and teamwork.
5	Nurture professional and ethical behavior.
6	Gain expertise that helps in building lifelong learning experience.

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Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. **Project Report Format:**
   At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

   A project report should preferably contain at least following details:
   - Abstract
   - Introduction
   - Literature Survey/ Existing system
   - Limitation Existing system or research gap
   - Problem Statement and Objective
   - Proposed System
     - Analysis/Framework/ Algorithm
     - Design details
     - Methodology (your approach to solve the problem) Proposed System
   - Experimental Set up

    - Details of Database or details about input to systems or selected data
    - Performance Evaluation Parameters (for Validation)
    - Software and Hardware Set up
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable:

Students should be encouraged -

- to participate in various project competition.
- to write minimum one technical paper & publish in good journal.
- to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Completeness of the project and Project Work Contribution
c. Project Report (Black Book) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral &Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as following:

a. Relevance to the specialization / industrial trends
b. Modern tools used
c. Innovation
d. Quality of work and completeness of the project
e. Validation of results
f. Impact and business value
g. Quality of written and oral presentation
h. Individual as well as team work

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UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean, Faculty of Science and Technology,
Member, Academic Council, RRC in Engineering
University of Mumbai

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Associate Dean, Faculty of Science and Technology,
Member, Academic Council, RRC in Engineering,
University of Mumbai

Program Structure for Second Year Computer Engineering

UNIVERSITY OF MUMBAI(With Effect from 2020-2021)

Semester III

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
CSC301	Applied Mathematics-III	3	--	1*	3	--	1	4
CSC302	Discrete Structures and Graph Theory	3		--	3		--	3
CSC303	Data Structure	3	--	--	3	--	--	3
CSC304	Digital Logic & Computer Architecture	3	--	--	3	--	--	3
CSC305	Computer Graphics	3	--	--	3	--	--	3
CSL301	Data Structure Lab	--	2	--	--	1	--	1
CSL302	Digital Logic & Computer Architecture Lab	--	2	--	--	1	--	1
CSL303	Computer Graphics Lab	--	2	--	--	1	--	1
CSL304	Skill base Lab course:Object Oriented Programming with Java	--	2+2*	--	--	2	--	2
CSM301	Mini Project – 1 A		$4^{\$}$			2		2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract &oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
CSC301	Applied Mathematics-III	20	20	20	80	3	25	--	125
CSC302	Discrete Structures and Graph Theory	20	20	20	80	3	--	--	100
CSC303	Data Structure	20	20	20	80	3	--	--	100
CSC304	Digital Logic & Computer Architecture	20	20	20	80	3	--	--	100
CSC305	Computer Graphics	20	20	20	80	3	--	--	100
CSL301	Data Structure Lab	--	--	--	--	--	25	25	50
CSL302	Digital Logic & Computer Architecture Lab	--	--	--	--	--	25		25
CSL303	Computer Graphics Lab	--	--	--	--	--	25	25	50
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	--	--	--	--	50	25	**75**
CSM301	Mini Project – 1 A						25	25	**50**
Total		**--**	**--**	**100**	**400**	**--**	**200**	**75**	**775**

*Should be conducted batchwise and

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

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Program Structure for Second YearComputer Engineering

UNIVERSITY OF MUMBAI(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CSC401	Applied Mathematics-IV	3	--	1*	3	--	1	4
CSC402	Analysis of Algorithm	3	--	--	3	--	--	3
CSC403	Database Management System	3	--	--	3	--	--	3
CSC404	Operating System	3	--	--	3	--	--	3
CSC405	Microprocessor	3	--	--	3	--	--	3
CSL401	Analysis of Algorithm Lab	--	2	--	--	1	--	1
CSL402	Database Management System Lab	--	2	--	--	1	--	1
CSL403	Operating System Lab	--	2	--	--	1	--	1
CSL404	Microprocessor Lab	--	2	--	--	1	--	1
CSL405	Skill Base Lab Course: Python Programming	--	2*+2	--	--	2	--	2
CSM401	Mini Project 1-B	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**16**	**1**	**15**	**7**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract &oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
CSC401	Applied Mathematics-IV	20	20	20	80	3	25	--	125
CSC402	Analysis of Algorithm	20	20	20	80	3	--	--	100
CSC403	Database Management System	20	20	20	80	3	--	--	100
CSC404	Operating System	20	20	20	80	3	--	--	100
CSC405	Microprocessor	20	20	20	80	3	--	--	100
CSL401	Analysis of Algorithm Lab	--	--	--	--	--	25	25	50
CSL402	Database Management System Lab	--	--	--	--	--	25	25	50
CSL403	Operating System Lab	--	--	--	--	--	25	25	50
CSL404	Microprocessor Lab	--	--	--	--	--	25	--	25
CSL405	Skill Base Lab Course: Python Programming	--	--	--	--	--	25	-	25
CSM401	Mini Project 1-B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**200**	**75**	**775**

*Should be conducted batchwise and

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups.

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Course Code	Course Name	Credits
CSC301	**Engineering Mathematics-III**	**4**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II	
Course Objectives: The course aims:	
1	To learn the Laplace Transform, Inverse Laplace Transform of various functions, itsapplications.
2	To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills.
3	To understand the concept of complex variables, C-R equations with applications.
4	To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning, and AI.
5	To understand some advanced topics of probability, random variables with their distributionsandexpectations.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2	Understand the concept of inverse Laplace transform of various functions and its applicationsin engineering problems.
3	Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
4	Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
6	Understand the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

Module	Detailed Contents		Hours
1	**Laplace Transform**		6
	1.1	Definition of Laplace transform, Condition of Existence of Laplace transform.	
	1.2	Laplace Transform (L) of standard functions like $e^{at}, sin(at), cos(at), sinh(at), cosh(at)$ and $t^n, n \geq 0$.	
	1.3	Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale, Multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof).	
	1.4	Evaluation of real improperintegrals by using Laplace Transformation.	
	1.5	**Self-learning Topics:**Laplace Transform: Periodic functions, Heaviside’s Unit Step function, Dirac Delta Function, Special functions (Error and Bessel)	
2	**Inverse Laplace Transform**		6
	2.1	Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace transform using derivatives.	
	2.2	Partial fractions method to find Inverse Laplace transform.	
	2.3	Inverse Laplace transform using Convolution theorem (without proof)	
	2.4	**Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	
3	**Fourier Series:**		6

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	3.1	Dirichlet’s conditions, Definition of Fourier series and Parseval’s Identity(withoutproof).	
	3.2	Fourier series of periodic function with period 2π and $2l$.	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
	3.5	**Self-learning Topics:** Orthogonal and orthonormal set of functions, Complex form of Fourier Series,Fourier Transforms.	
4	**Complex Variables:**		6
	4.1	Function *f(z)*of complex variable, Limit, Continuity andDifferentiability of*f(z),* Analytic function: Necessary and sufficient conditions for *f(z)* to beanalytic (without proof).	
	4.2	Cauchy-Riemann equations in Cartesiancoordinates (without proof).	
	4.3	Milne-Thomson method: Determine analytic function *f(z)*when real part (u), imaginary part (v) or its combination (u+v / u-v) is given.	
	4.4	Harmonic function, Harmonic conjugate and Orthogonal trajectories.	
	4.5	**Self-learning Topics:** Conformal mapping, Linear and Bilinear mappings, cross ratio, fixed points and standard transformations.	
5	**Statistical Techniques**		6
	5.1	Karl Pearson’s coefficient of correlation (r)	
	5.2	Spearman’s Rank correlation coefficient (R) (with repeated and non-repeated ranks)	
	5.3	Lines of regression	
	5.4	Fitting of first- and second-degree curves.	
	5.5	**Self-learning Topics:**Covariance, fitting of exponential curve.	
6	**Probability**		6
	6.1	Definition and basics of probability, conditional probability.	
	6.2	Total Probability theorem and Bayes’ theorem.	
	6.3	Discrete and continuous random variable with probability distribution and probabilitydensity function.	
	6.4	Expectation, Variance, Moment generating function, Raw and central moments up to 4th order.	
	6.5	**Self-learning Topics:** Skewness and Kurtosis of distribution (data).	

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References:	
1	Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication.
2	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited.
3	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
4	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
6	Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum’s Outline Series.

Term Work:	
General Instructions:	
1	Batch wise tutorialshave to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% ofthe syllabus is completed. The 2nd class test has to be conducted(Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions,each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours,as mentioned in the syllabus.

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Course Code	Course Name	Credits
CSC302	**Discrete Structures and Graph Theory**	**3**

Pre-requisite: Basic Mathematics	
Course Objectives: The course aims:	
1	Cultivate clear thinking and creative problem solving.
2	Thoroughly train in the construction and understanding of mathematical proofs. Exercisecommon mathematical arguments and proof strategies.
3	To apply graph theory in solving practical problems.
4	Thoroughly prepare for the mathematical aspects of other Computer Engineering courses
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2	Ability to reason logically.
3	Ability to understand relations, functions, Diagraph and Lattice.
4	Ability to understand and apply concepts of graph theory in solving real world problems.
5	Understand use of groups and codes in Encoding-Decoding
6	Analyze a complex computing problem and apply principles of discrete mathematics to identify solutions

Module	Detailed Contents		Hours
1	**Logic**		6
		Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Inference Theory of Predicate Calculus, Mathematical Induction.	
2	**Relations and Functions**		6
	2.1	Basic concepts of Set Theory	
	2.2	**Relations:** Definition, Types of Relations, Representation of Relations, Closures of Relations,Warshall'salgorithm, Equivalence relations and Equivalence Classes	
	2.3	**Functions**: Definition, Types of functions, Composition of functions, Identity and Inverse function	
3	**Posets and Lattice**		5
		Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattice, Sub lattice	
4	**Counting**		6
	4.1	Basic Counting Principle-Sum Rule, Product Rule, Inclusion-Exclusion Principle, Pigeonhole Principle	
	4.2	Recurrence relations,Solving recurrence relations	
5	**Algebraic Structures**		8
	5.1	**Algebraic structures with one binary operation:**Semi group, Monoid, Groups, Subgroups,Abelian Group, Cyclic group, Isomorphism	
	5.2	**Algebraic structures with two binary operations:** Ring	
	5.3	**Coding Theory**: Coding, binary information and error detection, decoding and error correction	
6	**Graph Theory**		8
		Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex, Applications.	

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Textbooks:

1	BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “DiscreteMathematical Structures”, Pearson Education.
2	C.L.Liu“Elements of Discrete Mathematics”, second edition 1985, McGraw-Hill BookCompany.Reprinted 2000.
3	K.H.Rosen, “Discrete Mathematics and applications”, fifth edition 2003, TataMcGraw Hill Publishing Company

References:

1	Y N Singh, “Discrete Mathematical Structures”, Wiley-India.
2	J. L.Mott, A.Kandel, T.P.Baker, “Discrete Mathematics for Computer Scientists andMathematicians”, second edition 1986, Prentice Hall of India.
3	J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”,TataMcgraw-Hill
4	Seymour Lipschutz, Marc Lars Lipson,“Discrete Mathematics” Schaum‟sOutline, McGrawHill Education.
5	NarsingDeo,“Graph Theorywith applications to engineering and computer science”, PHI Publications.
6	P.K.Bisht, H.S. Dhami, “Discrete Mathematics”, Oxford press.

Assessment:

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% ofthe syllabus is completed. The 2nd class test has to be conducted(Internal Assessment II) when an additional 40% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions,each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours,as mentioned in the syllabus.

Useful Links

1	https://www.edx.org/learn/discrete-mathematics
2	https://www.coursera.org/specializations/discrete-mathematics
3	https://nptel.ac.in/courses/106/106/106106094/
4	https://swayam.gov.in/nd1_noc19_cs67/preview

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Course Code	Course Name	Credit
CSC303	Data Structure	03

Pre-requisite: C Programming	
Course Objectives: The course aims:	
1	To understand the need and significance of Data structures as a computer Professional.
2	To teach concept and implementation of linear and Nonlinear data structures.
3	To analyze various data structures and select the appropriate one to solve a specific real-world problem.
4	To introduce various techniques for representation of the data in the real world.
5	To teach various searching techniques.
Course Outcomes:	
1	Students will be able to implement Linear and Non-Linear data structures.
2	Students will be able to handle various operations like searching, insertion, deletion and traversals on various data structures.
3	Students will be able to explain various data structures, related terminologies and its types.
4	Students will be able to choose appropriate data structure and apply it to solve problems in various domains.
5	Students will be able to analyze and Implement appropriate searching techniques for a given problem.
6	Students will be able to demonstrate the ability to analyze, design, apply and use data structures to solve engineering problems and evaluate their solutions.

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Module		Detailed Content	Hours
1		**Introduction to Data Structures**	**2**
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures.	
2		**Stack and Queues**	**8**
	2.1	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion.	
	2.2	Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue.	
3		**Linked List**	**9**
	3.1	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack and Queue using Singly Linked List, Singly Linked List Application-Polynomial Representation and Addition.	
4		**Trees**	**10**
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree.	
5		**Graphs**	**4**

	5.1	Introduction, Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS), Graph Application-Topological Sorting.	
6		**Searching Techniques**	**3**
	6.1	Linear Search, Binary Search, Hashing-Concept, Hash Functions, Collision resolution Techniques	

Textbooks:	
1	Aaron M Tenenbaum, YedidyahLangsam, Moshe J Augenstein, “Data Structures Using C”, Pearson Publication.
2	Reema Thareja, “Data Structures using C”, Oxford Press.
3	Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2ndEdition, CENGAGE Learning.
4	Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and Its Applications”, McGraw-Hill Higher Education
5	Data Structures Using C, ISRD Group, 2ndEdition, Tata McGraw-Hill.
References:	
1	Prof. P. S. Deshpande, Prof. O. G. Kakde, “C and Data Structures”, DreamTech press.
2	E. Balagurusamy, “Data Structure Using C”, Tata McGraw-Hill Education India.
3	Rajesh K Shukla, “Data Structures using C and C++”, Wiley-India
4	GAV PAI, “Data Structures”, Schaum’s Outlines.
5	Robert Kruse, C. L. Tondo, Bruce Leung, “Data Structures and Program Design in C”, Pearson Edition

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to beconducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://nptel.ac.in/courses/106/102/106102064/
2	https://www.coursera.org/specializations/data-structures-algorithms
3	https://www.edx.org/course/data-structures-fundamentals
4	https://swayam.gov.in/nd1_noc19_cs67/preview

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Course Code	Course Name	Credit
CSC304	**Digital Logic & Computer Organization and Architecture**	**3**

Pre-requisite: Knowledge on number systems	
Course Objective:	
1	To have the rough understanding of the basic structure and operation of basic digital circuits and digital computer.
2	To discuss in detail arithmetic operations in digital system.
3	To discuss generation of control signals and different ways of communication with I/O devices.
4	To study the hierarchical memory and principles of advanced computing.
Course Outcome:	
1	To learn different number systems and basic structure of computer system.
2	To demonstrate the arithmetic algorithms.
3	To understand the basic concepts of digital components and processor organization.
4	To understand the generation of control signals of computer.
5	To demonstrate the memory organization.
6	To describe the concepts of parallel processing and different Buses.

Module		Detailed Content	Hours
1		**Computer Fundamentals**	**5**
	1.1	Introduction to Number System and Codes	
	1.2	Number Systems: Binary, Octal, Decimal, Hexadecimal,	
	1.3	Codes: Grey, BCD, Excess-3, ASCII, Boolean Algebra.	
	1.4	Logic Gates: AND,OR,NOT,NAND,NOR,EX-OR	
	1.5	Overview of computer organization and architecture.	
	1.6	Basic Organization of Computer and Block Level functional Units, Von-Neumann Model.	
2		**Data Representation and Arithmetic algorithms**	**8**
	2.1	Binary Arithmetic: Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's and 2's compliment, BCD and Hex Arithmetic Operation.	
	2.2	Booths Multiplication Algorithm, Restoring and Non-restoring Division Algorithm.	
	2.3	IEEE-754 Floating point Representation.	
3		**Processor Organization and Architecture**	**6**
	3.1	Introduction: Half adder, Full adder, MUX, DMUX, Encoder, Decoder(IC level).	
	3.2	Introduction to Flip Flop: SR, JK, D, T (Truth table).	
	3.3	Register Organization, Instruction Formats, Addressing modes, Instruction Cycle, Interpretation and sequencing.	
4		**Control Unit Design**	**6**
	4.1	Hardwired Control Unit: State Table Method, Delay Element Methods.	
	4.2	Microprogrammed Control Unit: Micro Instruction-Format, Sequencing and execution, Micro operations, Examples of microprograms.	
5		**Memory Organization**	**6**
	5.1	Introduction and characteristics of memory, Types of RAM and ROM, Memory Hierarchy, 2-level Memory Characteristic,	
	5.2	Cache Memory: Concept, locality of reference, Design problems based on mapping techniques, Cache coherence and write policies. Interleaved and Associative Memory.	
6		**Principles of Advanced Processor and Buses**	**8**

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	6.1	Basic Pipelined Data path and control, data dependencies, data hazards, branch hazards, delayed branch, and branch prediction, Performance measures-CPI, Speedup, Efficiency, throughput, Amdhal’s law.	
	6.2	Flynn’s Classification, Introduction to multicore architecture.	
	6.3	Introduction to buses: ISA, PCI, USB. Bus Contention and Arbitration.	

Textbooks:

1	R. P. Jain, “Modern Digital Electronic”, McGraw-Hill Publication, 4thEdition.
2	William Stalling, “Computer Organization and Architecture: Designing and Performance”, Pearson Publication 10TH Edition.
3	John P Hayes, “Computer Architecture and Organization”, McGraw-Hill Publication, 3RD Edition.
4	Dr. M. Usha and T. S. Shrikanth, “Computer system Architecture and Organization”, Wiley publication.

References:

1	Andrew S. Tanenbaum, “Structured Computer Organization”, Pearson Publication.
2	B.Govindarajalu, “Computer Architecture and Organization”, McGraw-Hill Publication.
3	Malvino, “Digital computer Electronics”, McGraw-Hill Publication, 3rdEdition.
4	Smruti Ranjan Sarangi, “Computer Organization and Architecture”,McGraw-Hill Publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

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Useful Links

1	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2	https://nptel.ac.in/courses/106/103/106103068/
3	https://www.coursera.org/learn/comparch
4	https://www.edx.org/learn/computer-architecture

Course Code	Course Name	Credits
CSC305	**Computer Graphics**	**3**

Prerequisite: Knowledge of C Programming and Basic Mathematics**.**	
Course Objectives	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasize on implementation aspect of Computer Graphics Algorithms.
3	To prepare the student for advance areas and professional avenues in the field of Computer Graphics
Course Outcomes: At the end of the course, the students should be able to	
1	Describe the basic concepts of Computer Graphics.
2	Demonstrate various algorithms for basic graphics primitives.
3	Apply 2-D geometric transformations on graphical objects.
4	Use various Clipping algorithms on graphical objects
5	Explore 3-D geometric transformations, curve representation techniques and projections methods.
6	Explain visible surface detection techniques and Animation.

Module		Detailed Content	Hours
1		**Introduction and Overview of Graphics System:**	**02**
	1.1	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.	
	1.2	Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems.	
2		**Output Primitives:**	**10**
	2.1	Scan conversions of point, line, circle and ellipse: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected)	
	2.2	Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).	
	2.3	Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm.	
3		**Two Dimensional Geometric Transformations**	**5**
	3.1	Basic transformations: Translation, Scaling, Rotation	
	3.2	Matrix representation and Homogeneous Coordinates	
	3.3	Composite transformation	
	3.4	Other transformations: Reflection and Shear	
4		**Two-Dimensional Viewing and Clipping**	**6**
	4.1	Viewing transformation pipeline and Window to Viewport coordinate transformation	
	4.2	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.	
5		**Three Dimensional Geometric Transformations, Curves and Fractal Generation**	**8**
	5.1	3D Transformations: Translation, Rotation, Scaling and Reflection	
	5.2	Composite transformations: Rotation about an arbitrary axis	
	5.3	Projections – Parallel, Perspective. (Matrix Representation)	
	5.4	Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension,	

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		Koch Curve.	
6		**Visible Surface Detection and Animation**	**5**
	6.1	Visible Surface Detection:Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method,Area Subdivision method	
	6.2	Animation: Introduction to Animation,TraditionalAnimation Techniques,Principles of Animation,Key framing: Character and Facial Animation, Deformation, Motion capture	

Textbooks:	
1	Hearn &Baker,“Computer Graphics C version”, 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, “Computer Graphics Principles and Practice in C”, 2^{nd}Edition, Pearson Publication
3	Samit Bhattacharya,“Computer Graphics”,Oxford Publication
References:	
1	D. Rogers, “Procedural Elements for Computer Graphics”, Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, “Computer Graphics”, Schaum‟s Outlines McGraw-Hill Education
3	Rajesh K. Maurya,“Computer Graphics”,Wiley India Publication.
4	F.S.Hill, “Computer Graphics using OpenGL”, Third edition, Pearson Publications.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links	
1	https://www.classcentral.com/course/interactivegraphics-2067
2	https://swayam.gov.in/nd2_ntr20_ed15/preview
3	https://nptel.ac.in/courses/106/106/106106090/
4	https://www.edx.org/course/computer-graphics-2

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Lab Code	Lab Name	Credit
CSL301	Data Structures Lab	1

Prerequisite: C Programming Language.

Lab Objectives:

1	To implement basic data structures such as arrays, linked lists, stacks and queues
2	Solve problem involving graphs, and trees
3	To develop application using data structure algorithms
4	Compute the complexity of various algorithms.

Lab Outcomes:

1	Students will be able to implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them.
2	Students will be able to implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them
3	Students will be able to choose appropriate data structure and apply it in various problems
4	Students will be able to select appropriate searching techniques for given problems.

Suggested Experiments: Students are required to complete at least 10 experiments.

Star (*) marked experiments are compulsory.

Sr. No.	Name of the Experiment
1*	Implement Stack ADT using array.
2*	Convert an Infix expression to Postfix expression using stack ADT.
3*	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.
5*	Implement Linear Queue ADT using array.
6*	Implement Circular Queue ADT using array.
7	Implement Priority Queue ADT using array.
8*	Implement Singly Linked List ADT.
9*	Implement Circular Linked List ADT.
10	Implement Doubly Linked List ADT.
11*	Implement Stack / Linear Queue ADT using Linked List.
12*	Implement Binary Search Tree ADT using Linked List.
13*	Implement Graph Traversal techniques:) Depth First Search b) Breadth First Search
14	Applications of Binary Search Technique.

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Useful Links:

1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of CSL301and CSC303

Lab Code	Lab Name	Credit
CSL302	**Digital Logic & Computer Organization and Architecture Lab**	**1**

Prerequisite: C Programming Language.

Lab Objectives:

1	To implement operations of the arithmetic unit using algorithms.
2	Design and simulate different digital circuits.
3	To design memory subsystem including cache memory.
4	To demonstrate CPU and ALU design.

Lab Outcomes:

1	To understand the basics of digital components
2	Design the basic building blocks of a computer: ALU, registers, CPU and memory
3	To recognize the importance of digital systems in computer architecture
4	To implement various algorithms for arithmetic operations.

List of Experiments:

Sr. No.	**Name of the Experiment**
1	To verify the truth table of various logic gates using ICs.
2	To realize the gates using universal gates
3	Code conversion.
4	To realize half adder and full adder.
5	To implement logic operation using MUX IC.
6	To implement logic operation decoder IC.
7	Study of flip flop IC.
8	To implement ripplecarry adder.
9	To implement carry look ahead adder.
10	To implement Booth's algorithm.
11	To implement restoring division algorithm.
12	To implement non restoring division algorithm.
13	To implement ALU design.
14	To implement CPU design.
15	To implement memory design.
16	To implement cache memory design.

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Note:

1	Any Four experiments from Exp. No. 1 to Exp. No. 7 using hardware.
2	Any Six experiments from Exp. No. 8 to Exp. No. 16 using Virtual Lab, expectExp. No 10,11 and 12.
3	Exp. No. 10 to Exp. No. 12 using Programming language.

Digital Material:

1	Manual to use Virtual Lab simulator for Computer Organization and Architecture developed by the Department of CSE, IIT Kharagpur.
2	Link http://cse10-iitkgp.virtual-labs.ac.in/

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignmentson content of theory and practical of "Digital Logic &Computer Organization and Architecture"
3	The final certification and acceptance of term work ensures that satisfactory performance of

	laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of “Digital Logic &Computer Organization and Architecture”

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Course Code	Lab Name	Credits
CSL303	Computer Graphics Lab	1

Prerequisite: C Programming Language.

Lab Objectives:

1	Understand the need of developing graphics application
2	Learn algorithmic development of graphics primitives like: line, circle, polygon etc.
3	Learn the representation and transformation of graphical images and pictures

Lab Outcomes: At the end of the course, the students should be able to

1	Implement various output and filled area primitive algorithms
2	Apply transformation, projection and clipping algorithms on graphical objects.
3	Perform curve and fractal generation methods.
4	Develop a Graphical application/Animation based on learned concept

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation Curves Visible surface determination. Simple animations Application of these through exercises in C/C++

List of Suggested Experiments:

Sr. No.	Name of the Experiment
1	Implement DDA Line Drawing algorithm (dotted/dashed/thick)
2	Implement Bresenham's Line algorithm(dotted/dashed/thick)
3	Implement midpoint Circle algorithm.
4	Implement midpoint Ellipse algorithm.
5	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.
6	Implement Scan line Polygon Filling algorithm.
7	Implement Curve: Bezier for n control points, B Spline (Uniform)(at least one)
8	Implement Fractal generation method (anyone)
9	Character Generation: Bit Map method and Stroke Method
10	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.
11	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.
12	Implement polygon clipping algorithm (at least one)
13	Program to perform 3D transformation.
14	Program to perform projection of a 3D object on Projection Plane: Parallel and Perspective.
15	Program to perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc.)

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Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments
3	Mini Project to perform using C /C++/Java/OpenGL/Blender/ any other tool (2/3 students per group).Possible Ideas:Animation using multiple objects, Game development, Graphics editor: Like Paint brush, Text editor etc.
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Experiments: 10-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks, Mini Project: 5-marks)

Oral & Practical exam

Based on the above contents and entire syllabus of CSC305

Lab Code	Lab Name	Credits
CSL304	**Skill based Lab Course: Object Oriented Programming with Java**	**2**

Prerequisite: Structured Programming Approach	
Lab Objectives:	
1	To learn the basic concepts of object-oriented programming
2	To study JAVA programming language
3	To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc.
4	To explain components of GUI based programming.
Lab Outcomes: At the end of the course, the students should be able to	
1	To apply fundamental programming constructs.
2	To illustrate the concept of packages, classes and objects.
3	To elaborate the concept of strings, arrays and vectors.
4	To implement the concept of inheritance and interfaces.
5	To implement the concept of exception handling and multithreading.
6	To develop GUI based application.

Module		Detailed Content	Hours
1		**Introduction to Object Oriented Programming**	**2**
	1.1	OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing.	
	1.2	Java Virtual Machine	
	1.3	Basic programming constructs: variables, data types, operators, unsigned right shift operator, expressions, branching and looping.	
2		**Class, Object, Packages and Input/output**	**6**
	2.1	Class, object, data members, member functions Constructors, types, static members and functions Method overloading Packages in java, types, user defined packages Input and output functions in Java, Buffered reader class, scanner class	
3		**Array, String and Vector**	**3**
	3.1	Array, Strings, String Buffer, Vectors	
4		**Inheritance**	**4**
	4.1	Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritance using interface, extends keyword	
5		**Exception handling and Multithreading**	**5**
	5.1	Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks, user defined exception Thread lifecycle, thread class methods, creating threads using extends and implements keyword.	
6		**GUI programming in JAVA**	**6**
	6.1	Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class AWT: working with windows, using AWT controls for GUI design Swing class in JAVA Introduction to JDBC, JDBC-ODBC connectivity, JDBC architecture.	

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Textbooks:	
1	Herbert Schildt, ‘JAVA: The Complete Reference’, Ninth Edition, Oracle Press.
2	E. Balagurusamy, ‘Programming with Java’, McGraw Hill Education.

References:	
1	Ivor Horton, “Beginning JAVA“, Wiley India.
2	DietalandDietal, “Java: How to Program“, 8th Edition,PHI .
3	“JAVA Programming“, Black Book, Dreamtech Press.
4	“Learn to Master Java programming“, Staredu solutions

Digital material:	
1	www.nptelvideos.in
2	www.w3schools.com
3	www.tutorialspoint.com
4	https://starcertification.org/Certifications/Certificate/securejava

Suggested List of Programming Assignments/laboratory Work:

Sr. No.	**Name of the Experiment**
1	Programs on Basic programming constructs like branching and looping
2	Program on accepting input through keyboard.
3	Programs on class and objects
4	Program on method and constructor overloading.
5	Program on Packages
6	Program on 2D array, strings functions
7	Program on StringBuffer and Vectors
8	Program on types of inheritance
9	Program on Multiple Inheritance
10	Program on abstract class and abstract methods.
11	Program using super and final keyword
12	Program on Exception handling
13	Program on user defined exception
14	Program on Multithreading
15	Program on Graphics class
16	Program on applet class
17	Program to create GUI application
18	Mini Project based on the content of the syllabus(Group of 2-3 students)

Term Work:	
1	Term work should consist of 15 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus(Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 50-Marks (Experiments: 15-marks, Attendance: 05-marks, Assignments: 05-marks, Mini Project: 20-marks, MCQ as a part of lab assignments: 5-marks)

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Course code	Course Name	Credits
CSM301	Mini Project A	02

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

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Term Work
The review/ progress monitoring committee shall be constituted by head of departments of each

institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:		**Marks**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1 In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.

2 In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

- First review is based on readiness of building working prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

1 In this case in one semester students' group shall complete project in all aspects including,

- Identification of need/problem
- Proposed final solution
- Procurement of components/systems
- Building prototype and testing

2 Two reviews will be conducted for continuous assessment,

- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms

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12	Contribution of an individual’s as member or leader
13	Clarity in written and oral communication
	In **one year, project**, first semester evaluation may be based on first six criteria’s and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of **half year project** all criteria’s in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual’s as member or leader
8	Clarity in written and oral communication

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Course Code	Course Name	Credits
CSC401	Engineering Mathematics-IV	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.	
Course Objectives: The course aims to learn:	
1	Matrix algebra to understand engineering problems.
2	Line and Contour integrals and expansion of a complex valued function in a power series.
3	Z-Transforms and Inverse Z-Transforms with its properties.
4	The concepts of probability distributions and sampling theory for small samples.
5	Linear and Non-linear programming problems of optimization.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Apply the concepts of eigenvalues and eigenvectors in engineering problems.
2	Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3	Apply the concept of Z- transformation and inverse in engineering problems.
4	Use the concept of probability distribution and sampling theory to engineering problems.
5	Apply the concept of Linear Programming Problems to optimization.
6	Solve Non-Linear Programming Problems for optimization of engineering problems.

Module	Detailed Contents		Hours
1	**Linear Algebra (Theory of Matrices)**		6
	1.1	Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof)	
	1.2	Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials	
	1.3	Similarity of matrices, diagonalizable and non-diagonalizable matrices	
	1.4	**Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	
2	**Complex Integration**		7
	2.1	Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof).	
	2.2	Taylor's and Laurent's series (without proof).	
	2.3	Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof)	
	2.4	**Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	
3	**Z Transform**		5
	3.1	Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}, \{a^{\lvert k\rvert}\}, \{{}^{k+n}_{\ \ n}C.\, a^k\}, \{c^k \sin(\alpha k+\beta)\}, \{c^k \sinh \alpha k\}, \{c^k \cosh \alpha k\}$.	
	3.2	Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem.	
	3.3	Inverse Z transform: Partial Fraction Method, Convolution Method.	
	3.4	**Self-learning Topics:** Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	
4	**Probability Distribution and Sampling Theory**		6
	4.1	Probability Distribution: Poisson and Normal distribution	

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	4.2	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom.	
	4.3	Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test ofgoodness of fit and independence of attributes, Contingency table.	
	4.4	**Self-learning Topics:** Test significance for Large samples, Estimate parameters of a population, Yate's Correction.	
5	**Linear Programming Problems**		6
	5.1	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method.	
	5.2	Artificial variables, Big-M method (Method of penalty)	
	5.3	Duality, Dual of LPP and Dual Simplex Method	
	5.4	**Self-learning Topics:** SensitivityAnalysis,Two-Phase Simplex Method, Revised Simplex Method.	
6	**Nonlinear Programming Problems**		6
	6.1	NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers	
	6.2	NLPP with two equality constraints	
	6.3	NLPP with inequality constraint: Kuhn-Tucker conditions	
	6.4	**Self-learning Topics:** Problems with two inequality constraints, Unconstrained optimization: One-dimensional search method (Golden Search method, Newton's method). Gradient Search method	

References:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons.
2	R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa.
3	Brown and Churchill, "Complex Variables and Applications", McGraw-Hill Education.
4	T. Veerarajan, "Probability, Statistics and Random Processes", McGraw-Hill Education.
5	Hamdy A Taha, "Operations Research: An Introduction", Pearson.
6	S.S. Rao, "Engineering Optimization: Theory and Practice", Wiley-Blackwell.
7	Hira and Gupta, "Operations Research", S. Chand Publication.

Term Work:		
General Instructions:		
1	Batch wise tutorialshave to be conducted. The number of students per batch will be as per University pattern for practical.	
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.	
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.	
The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:
Internal Assessment Test:
The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% ofthe syllabus is completed. The 2nd class test has to be conducted(Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test will be for one hour.

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End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions,each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours,asmentioned in the syllabus.

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Course Code	Course Name	Credit
CSC402	Analysis of Algorithms	3

Prerequisite: Data structure concepts, Discrete structures	
Course Objectives:	
1	To provide mathematical approaches for Analysis of Algorithms
2	To understand and solve problems using various algorithmic approaches
3	To analyze algorithms using various methods
Course Outcomes: At the end of the course learner will be able to	
1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

Module		Detailed Contents	Hours
1		**Introduction**	8
	1.1	Performance analysis, space and time complexityGrowth of function, Big- Oh,Omega Theta notationMathematical background for algorithm analysis. Complexity class: Definition of P, NP, NP-Hard, NP-CompleteAnalysis of selection sort, insertion sort.	
	1.2	Recurrences:The substitution method, Recursion tree method, Master method	
2		**Divide and Conquer Approach**	6
	2.1	General method, Merge sort, Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	
3		**Greedy Method Approach**	6
	3.1	General Method, Single source shortest path: Dijkstra AlgorithmFractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms	
4		**Dynamic Programming Approach**	9
	4.1	General Method, Multistage graphs, Single source shortest path:Bellman Ford Algorithm All pair shortest path: Floyd Warshall Algorithm, Assembly-line scheduling Problem0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence	
5		**Backtracking and Branch and bound**	6
	5.1	General Method, Backtracking:N-queen problem, Sum of subsets, Graph coloring	
	5.2	Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem	
6		**String Matching Algorithms**	4
	6.1	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	

Textbooks:	
1	T. H. Cormen, C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2	Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.
References:	

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1	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw-Hill Edition.
2	S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

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Course Code:	Course Title	Credit
CSC403	Database Management System	3

Prerequisite: Data Structures	
Course Objectives:	
1	Develop entity relationship data model and its mapping to relational model
2	Learn relational algebra and Formulate SQL queries
3	Apply normalization techniques to normalize the database
4	Understand concept of transaction, concurrency control and recovery techniques.
Course Outcomes:	
1	Recognize the need of database management system
2	Design ER and EER diagram for real life applications
3	Construct relational model and write relational algebra queries.
4	Formulate SQL queries
5	Apply the concept of normalization to relational database design.
6	Describe the concept of transaction, concurrency and recovery.

Module		Content	Hrs
1		**Introduction Database Concepts**	**3**
	1.1	Introduction, Characteristics of databases, File system v/s Databasesystem, Data abstraction and data Independence,DBMS system architecture, Database Administrator	
2		**Entity–Relationship Data Model**	**6**
	2.1	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		**Relational Model and relational Algebra**	**8**
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model, Relational Algebra-operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	**6**
	4.1	Overview of SQL, Data Definition Commands, Integrity constraints:key constraints, Domain Constraints, Referential integrity , check constraints, Data Manipulation commands, Data Control commands,Set and string operations, aggregate function-group by, having, Views in SQL, joins, Nested and complex queries,Triggers	
5		**Relational-Database Design**	**6**
	5.1	Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	**10**
	6.1	Transaction concept, Transaction states, ACID properties,Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery,Deadlock handling	

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Textbooks:	
1	Korth, Slberchatz,Sudarshan, Database System Concepts, 6thEdition, McGraw Hill
2	Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, Pearson Education
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
References:	
1	Peter Rob and Carlos Coronel,Database Systems Design, Implementation and Management‖, Thomson Learning, 5thEdition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	G. K. Gupta, Database Management Systems, McGraw Hill, 2012

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105175/
2	https://swayam.gov.in/nd1_noc19_cs46/preview
3	https://www.classcentral.com/course/swayam-database-management-system-9914
4	https://www.mooc-list.com/tags/dbms

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Course Code	Course Name	Credit
CSC404	Operating System	03

Prerequisites: Data structures and Computer architecture	
Course Objectives:	
1	1. To introduce basic concepts and functions of operating systems.
2	2. To understand the concept of process, thread and resource management.
3	3. To understand the concepts of process synchronization and deadlock.
4	4. To understand various Memory, I/O and File management techniques.
Course Outcome:	
1	Understand the objectives, functions and structure of OS
2	Analyze the concept of process management and evaluate performance of processscheduling algorithms.
3	Understand and apply the concepts of synchronization and deadlocks
4	Evaluate performance of Memory allocation and replacement policies
5	Understand the concepts of file management.
	Apply concepts of I/O management and analyze techniques of disk scheduling.

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Module	Detailed Content		Hours
1	**Operating system Overview**		**4**
	1.1	Introduction, Objectives, Functions and Evolution of Operating System	
	1.2	Operating system structures: Layered, Monolithic and Microkernel	
	1.3	Linux Kernel, Shell and System Calls	
2	**Process and Process Scheduling**		**9**
	2.1	Concept of a Process, Process States,Process Description, Process Control Block.	
	2.2	Uniprocessor Scheduling-Types: Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority,RR)	
	2.3	Threads: Definition and Types, Concept ofMultithreading	
3	**Process Synchronization and Deadlocks**		**9**
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	
	3.2	Mutual Exclusion: Requirements, Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem.	
	3.3	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention,Deadlock Avoidance: Banker‟s Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	
4	**Memory Management**		**9**
	4.1	Memory Management Requirements,Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit,Paging and Segmentation, TLB	
	4.2	Virtual Memory: Demand Paging,Page Replacement Strategies: FIFO, Optimal, LRU,Thrashing	
5		**File Management**	**4**
	5.1	Overview, File Organization and Access, File Directories, File Sharing	
6		**I/O management**	**4**

	6.1	I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling:FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK.	

Textbooks:	
1	William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918.
2	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
References:	
1	Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition
2	Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.
3	Maurice J. Bach, “Design of UNIX Operating System”, PHI
4	Sumitabha Das, “UNIX: Concepts and Applications”,McGraw Hill, 4thEdition

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links	
1	https://swayam.gov.in/nd1_noc19_cs50/preview
2	https://nptel.ac.in/courses/117/106/117106113/
3	https://www.classcentral.com/course/swayam-introduction-to-operating-systems-6559

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Course Code	Course Name	Credits
CSC405	**Microprocessor**	**3**

Prerequisites: Digital Logic and Computer Architecture

Course objectives:

1	To equip students with the fundamental knowledge and basic technical competence in thefield of Microprocessors.
2	To emphasize on instruction set and logic to build assembly language programs.
3	To prepare students for higher processor architectures and embedded systems

Course outcomes: On successful completion of course, learner will be able to:

1	Describe core concepts of 8086 microprocessor.
2	Interpret the instructions of 8086 and write assembly and Mixed language programs.
3	Identify the specifications of peripheral chip.
4	Design 8086 based system using memory and peripheral chips.
5	Appraise the architecture of advanced processors
6	Understand hyperthreading technology

Module	Detailed Contents		Hours
1	**The Intel Microprocessors 8086 Architecture**		8
	1.1	8086CPU Architecture,	
	1.2	Programmer's Model	
	1.3	Functional Pin Diagram	
	1.4	Memory Segmentation	
	1.5	Banking in 8086	
	1.6	Demultiplexing of Address/Data bus	
	1.7	Functioning of 8086 in Minimum mode and Maximum mode	
	1.8	Timing diagrams for Read and Write operations in minimum and maximum mode	
	1.9	Interrupt structure and its servicing	
2	**Instruction Set and Programming**		**6**
	2.1	Addressing Modes	
	2.2	Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
	2.3	Assembler Directives and Assembly Language Programming, Macros, Procedures	
3	**Memory and Peripherals interfacing**		**8**
	3.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2	8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3	8257-DMAC-Block diagram, DMA operations and transfer modes.	
	3.4	Programmable Interrupt Controller 8259-Block Diagram, Interfacing the 8259 in single and cascaded mode.	
4	**Intel 80386DX Processor**		**7**
	4.1	Architecture of 80386 microprocessor	
	4.2	80386 registers – General purpose Registers, EFLAGS and Control registers	

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	4.3	Real mode, Protected mode, virtual 8086 mode	
	4.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
5	**Pentium Processor**		**6**
	5.1	Pentium Architecture	
	5.2	Superscalar Operation,	
	5.3	Integer &Floating-Point Pipeline Stages,	
	5.4	Branch Prediction Logic,	
	5.5	Cache Organization and	
	5.6	MESI protocol	
6	**Pentium 4**		**4**
	6.1	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium III	
	6.2	Pentium 4: Net burst micro architecture.	
	6.3	Instruction translation look aside buffer and branch prediction	
	6.4	Hyper threading technology and its use in Pentium 4	

Textbooks:	
1	John Uffenbeck, “8086/8088 family: Design Programming and Interfacing”, PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, “Microcomputer System: The 8086/8088 Family,Architecture, Programming and Design”, Prentice Hall
3	Walter A.Triebel, “The 80386DX Microprocessor: hardware, Software and Interfacing”, Prentice Hall
4	Tom Shanley and Don Anderson, “Pentium Processor System Architecture”, Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, “Advanced Microprocessors and Peripherals”, McGraw Hill
References:	
1	Barry B. Brey, “Intel Microprocessors”, 8th Edition, Pearson Education India
2	Douglas Hall, “Microprocessor and Interfacing”, Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, “IBM PC Assembly language and Programming”, 5th Edition, PHI
5	James Antonakons, “The Pentium Microprocessor”, Pearson Education

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Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://swayam.gov.in/nd1_noc20_ee11/preview
2	https://nptel.ac.in/courses/108/105/108105102/
3	https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894
4	https://www.mooc-list.com/tags/microprocessors

Course Name	Lab Name	Credit
CSL401	**Analysis of Algorithms Lab**	**1**

Prerequisite: Basic knowledge of programming and data structure	
Lab Objectives:	
1	To introduce the methods of designing and analyzing algorithms
2	Design and implement efficient algorithms for a specified application
3	Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4	Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.
Lab Outcomes: At the end of the course, the students will be able to	
1	Implement the algorithms using different approaches.
2	Analyze the complexities of various algorithms.
3	Compare the complexity of the algorithms for specific problem.

Description
Implementation can be in any language.
Suggested Practical List:

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Sr No		**Suggested Experiment List**
1		**Introduction**
	1.1	Selection sort, Insertion sort
2		**Divide and Conquer Approach**
	2.1	Finding Minimum and Maximum, Merge sort, Quick sort, Binary search
3		**Greedy Method Approach**
	3.1	Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm
4		**Dynamic Programming Approach**
	4.1	Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Travelling salesperson problem Longest common subsequence
5		**Backtracking and Branch and bound**
	5.1	N-queen problem Sum of subsets Graph coloring
6		**String Matching Algorithms**
	6.1	The Naïve string-matching Algorithms The Rabin Karp algorithm The Knuth-Morris-Pratt algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignmentson content of theory and practical of "Analysis of Algorithms"
3	The final certification and acceptance of term work ensures that satisfactory performance of

	laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC402: Analysis of Algorithms

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Lab Code	Lab Name	Credit
CSL402	**Database Management system Lab**	**1**

Prerequisite: Discrete Structures

Lab Objectives:

1	To explore design and develop of relational model
2	To present SQL and procedural interfaces to SQL comprehensively
3	To introduce the concepts of transactions and transaction processing

Lab Outcomes: At the end of the course, the students will be able to

1	Design ER /EER diagram and convert to relational model for the realworld application.
2	Apply DDL, DML, DCL and TCL commands
3	Write simple and complex queries
4	UsePL / SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement variousJoin operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions
10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignmentson content of theory and practical of “Database Management System”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of CSC403: Database Management System

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Course Code	Course Name	Credit
CSL403	**Operating System Lab**	**01**

Prerequisite: Knowledge on Operating system principles	
Lab Objectives:	
1	To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment.
2	To familiarize students with the architecture of Linux OS.
3	To provide necessary skills for developing and debugging programs in Linux environment.
4	To learn programmatically to implement simple operation system mechanisms
Lab Outcomes: At the end of the course, the students will be able to	
1	Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrt Linux
2	Implement various process scheduling algorithms and evaluate their performance.
3	Implement and analyze concepts of synchronization and deadlocks.
4	Implement various Memory Management techniques and evaluate their performance.
5	Implement and analyze concepts of virtual memory.
6	Demonstrate and analyze concepts of file management and I/O management techniques.

Suggested List of Experiments

Sr. No.		**Content**
1		**Explore Linux Commands**
	1.1	**Explore usage of basic Linux Commands and system calls for file, directory and process management.** For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.)
2		**Linux shell script**
	2.1	Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. e. Display current shell, home directory, operating system type, current path setting, current working directory.
3.		**Linux- API**
	3.1	Implement any one basic commands of linux like ls, cp, mv and others using kernel APIs.
4.		**Linux- Process**
	4.1	a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and

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		getppid system call. b. Explore wait and waitpid before termination of process.
5		**Process Management: Scheduling**
	5.1	a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms
6		**Process Management: Synchronization**
	6.1	Write a C program to implement solution of Producer consumer problem through Semaphore
7		**Process Management: Deadlock**
	7.1	a. Write a program to demonstrate the concept of deadlock avoidance through Banker’s Algorithm b. Write a program demonstrate the concept of Dining Philospher’s Problem
8.		**Memory Management**
	8.1	a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.
9		**Memory Management: Virtual Memory**
	9.1	a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.
10		**File Management & I/O Management**
	10.1	a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. c. Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN

Term Work:	
1	Term work should consist of 10 experiments covering all modules.
2	Journal must include at least 2 assignments on content of theory and practical of “Database Management System”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC405: Operating System.

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Lab Code	**Lab Name**	**Credits**
CSL404	**Microprocessor Lab**	**1**

Prerequisite: Basic knowledge digital integrated circuits

Lab Objectives:

1	To emphasize on use of Assembly language program.
2	To prepare students for advanced subjects like embedded system and IOT.

Lab Outcomes: At the end of the course, the students will be able to

1	Use appropriate instructions to program microprocessor to perform various task
2	Develop the program in assembly/ mixed language for Intel 8086 processor
3	Demonstrate the execution and debugging of assembly/ mixed language program

Suggested List of Experiments:

Sr. No.	**Title of Experiments**
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8-bit/16-bit data
2	Code conversion (Hex to BCD and BCD to Hex)/ (ASCII to BCD and BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Any Mixed Language programs.
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order
9	Any program using INT 10H
10	Assembly program to find minimum/ maximum number from a given array.
11	Assembly Program to display a message in different color with blinking
12	Assembly program using procedure.
13	Assembly program using macro.
14	Program and interfacing using 8255.
15	Program and interfacing of ADC/ DAC/ Stepper motor.

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Term Work:

1	Term work should consist of 10 experiments, out of theses at least one experiment on hardware interfacing.
2	Journal must include at least 2 assignmentson content of theory and practical of “Microprocessor”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of CSL501and CSC501syllabus.

Lab Code	Lab Name	Credit
CSL405	**Skill Base Lab Course: Python Programming**	**2**

Prerequisite: Knowledge of some programming language like C, Java

Lab Objectives:

1	Basics of Python programming
2	Decision Making, Data structure and Functions in Python
3	Object Oriented Programming using Python
4	Web framework for developing

Lab Outcomes: At the end of the course, the students will be able to

1	To understand basic concepts in python.
2	To explore contents of files, directories and text processing with python
3	To develop program for data structure using built in functions in python.
4	To explore django web framework for developing python-based web application.
5	To understand Multithreading concepts using python.

Module		Detailed Content	Hours
1		**Python basics**	**5**
	1.1	Data types in python, Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes, Objects, Interfaces, Inheritance	
2		**Advanced Python**	**4**
	2.1	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.	
3		**Data Structure in Python**	**3**
	3.1	Link List, Stack, Queues, Dequeues	
4		**Python Integration Primer**	**4**
	4.1	Graphical User interface, Networking in Python, Python database connectivity, Introduction to Django	
5		**Multithreading**	**4**
	5.1	Thread and Process,Starting a thread,Threading module, Synchronizing threads,Multithreaded Priority Queue	
6		**NumPy and Pandas**	**6**
	6.1	Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types,Array Attribute,Indexing and Slicing,Creating array views copies,Manipulating array shapes I/O	
	6.2	Basics of Pandas,Using multilevel series,Series and Data Frames,Grouping, aggregating,Merge DataFrames	

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Textbooks:

1	Dr. R. Nageswara Rao, “Core Python Programming”, DreamtechPress
2	Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication
3	Anurag Gupta,G. P. Biswas, “Python Programming”,McGraw-Hill
4	E Balagurusamy, “Introduction to computing and problem-solving using python”,McGrawHill Education

References:

1	Learn Python the Hard Way, 3rd Edition, Zed Shaw's Hard WaySeries
2	Laura Cassell,Alan Gauld, “Python Projects”, Wrox Publication

Digital material:	
1	"The Python Tutorial",http://docs.python.org/release/3.0.1/tutorial/
2	Beginning Perl,https://www.perl.org/books/beginning-perl/
3	http://spoken-tutorial.org
4	https://starcertification.org/Certifications/Certificate/python

Suggested experiments using Python:	
Sr. No.	**Title of Experiments**
1	Exploring basics of python like data types (strings,list,array,dictionaries,set,tuples) andcontrolstatements.
2	Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
3	Exploring Files anddirectories a. Python program to append data to existing file and then display the entirefile b. Python program to count number of lines, words and characters in afile. c. Python program to display file available in currentdirectory
4	Creating GUI with python containing widgets such as labels, textbox,radio,checkboxes and custom dialogboxes.
5	Menu driven program for data structure using built in function for link list, stack andqueue.
6	Program to demonstrate CRUD(**create, read, update and delete)** operations on database (SQLite/ MySQL) usingpython
7	Creation of simple socket for basic information exchange between server andclient.
8	Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regularexpression).
9	Programs on Threading using python.
10	Exploring basics of NumPy Methods.
11	Program to demonstrate use of NumPy:Array objects.
12	Program to demonstrate Data Series and Data Frames using Pandas.
13	Program to send email and read content ofURL.

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Term Work:	
1	Term work should consist of 12 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus(Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 50-Marks (Experiments: 10-marks,Assignments: 05-marks, Mini Project: 10-marks)
Oral & Practical exam	
Based on the entire syllabus of CSL 405.	

Course code	Course Name	Credits
CSM401	**Mini Project B**	**02**

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

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Term Work

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

	Distribution of Term work marks for both semesters shall be as below:	**Marks**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1. In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
2. In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

1. In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
2. Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements

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10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual’s as member or leader
13	Clarity in written and oral communication
	In **one year, project**, first semester evaluation may be based on first six criteria’s and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of **half year project** all criteria’s in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual’s as member or leader
8	Clarity in written and oral communication

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UNIVERSITY OF MUMBAI

No. UG/43 of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/243 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.54 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. & B.E. in Electronics Engineering (Sem - V to VIII) has been brought into force with effect from the academic year 2018-19 and 2019-2020, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
25th June, 2018

(Dr. Dinesh Kamble)
I/c REGISTRAR

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.54/05/05/2018

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No. UG/ 43 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

AC19.04.2017
Item No. X.XX

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman’s Preamble:

Engineering education in India is expanding and is set to increase manifold. Themajor challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards.The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Electronics Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Electronics Engineering. The Program Educational Objectives finalized for the undergraduate program in Electronics Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner’s point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr.Sudhakar S. Mande
Chairman, Board of Studies in Electronics Engineering, University of Mumbai

S.E. (Electronics Engineering) – Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	---	01@	04	---	01	05
ELX302	Electronic Devices and Circuits I	04	---	---	04	---	---	04
ELX303	Digital Circuit Design	04	---	---	04	---	---	04
ELX304	Electrical Network Analysis and Synthesis	04	---	---	04	---	---	04
ELX305	Object Oriented Programming Methodology	04	---	---	04	---	---	04
ELXL301	Electronic Devices and Circuits I Lab		02	---	---	01	---	01
ELXL302	Digital Circuit Design Lab.		02	---	---	01	---	01
ELXL303	Electrical Network Analysis and Synthesis Lab		02	---	---	01	---	01
ELXL304	Object Oriented Programming Methodology Lab.		02+02#	---	---	02	---	02
	Total	**20**	**08**	**02**	**20**	**04**	**01**	**26**

@1 hour tutorial class-wise

#02 hours class-wise and 02 hours batch-wise

Course Code	Course Name	Examination Scheme – Semester III							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX301	Applied Mathematics III	20	20	20	80	03	25	---	125
ELX302	Electronic Devices and Circuits I	20	20	20	80	03	--	---	100
ELX303	Digital Circuit Design	20	20	20	80	03	---	---	100
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	03	---	---	100
ELX305	Object Oriented Programming Methodology	20	20	20	80	03	---	---	100
ELXL301	Electronic Devices and Circuits I Lab						25	25	50
ELXL302	Digital Circuit Design Lab.						25	25	50
ELXL303	Object Oriented Programming Methodology Lab.						25	25	50
ELXL304	Electrical Network Analysis and Synthesis Lab						25	---	25
Total		**100**	**100**	**100**	**400**	**15**	**125**	**75**	**700**

T.E. (Electronics Engineering) – Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX501	Microcontrollers and Applications	04	--	---	04	---	---	04
ELX 502	Digital Communication	04	-	--	04	---	---	04
ELX 503	Engineering Electromagnetics	04	-	@01	04	---	01	05
ELX 504	Design with Linear Integrated Circuits	04	02	---	04	---	---	04
ELX 505	Business Communication & Ethics	02	02#		---	02	---	02
ELXDLO501X	Department Level optional courses I	04	02	---	04		---	04
ELXL501	Microcontrollers and Applications Lab.					01	---	01
ELXL502	Digital Communication Lab.					01	---	01
ELXL503	Design with Linear Integrated Circuits Lab.					01	---	01
ELX DLOl50X	Department Level optional course-I Lab					01	---	01
	TOTAL	**20**	**08**	**04**	**20**	**06**	**01**	**27**

1 hour tutorial class-wise #02 hours batch-wise

Course Code	Course Name	Examination Scheme – Semester V							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX501	Micro-controllers and Applications	20	20	20	80	03	---	---	100
ELX 502	Digital Communication	20	20	20	80	03	---	---	100
ELX 503	Engineering Electromagnetics	20	20	20	80	03	25	---	125
ELX 504	Design with Linear Integrated Circuits	20	20	20	80	03	---	---	100
ELX 505	Business Communication & Ethics	---	---	---	---	---	50	---	50
ELX DLO501X	Department Level Elective-I	20	20	20	80	03	---	---	100
ELXL501	Micro-controllers and Applications Lab.						25	25	50
ELXL 502	Digital Communication Lab.						25	---	25
ELXL 503	Design with Linear Integrated Circuits Lab.						25	25	50
ELXL DLO501X	Department Elective I lab						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**175**	**75**	**750**

Course Code	Department Level Optional Course I
ELXDLO5011	Database and Management System
ELXDLO5012	Digital Control system
ELXDLO5013	ASIC Verification
ELXDLO5014	Biomedical Instrumentation

T.E. (Electronics Engineering) – Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX601	Embedded System and RTOS	04	--	---	04	---	---	04
ELX 602	Computer Communication Network	04	--	---	04	---	---	04
ELX 603	VLSI Design	04	--	---	04	---	---	04
ELX 604	Signals and systems	04	--	@01	04	---	01	05
ELXDLO502X	Department Level Optional courses II	04	--	---	04	---	---	04
ELXL601	Embedded System and RTOS Lab.	--	02	--	--	01	---	01
ELXL 602	Computer Communication Network Lab.	--	02	--	--	01	--	01
ELXL 603	VLSI Design Lab.	--	02	--		01	---	01
ELXLDLO601 X	Department Level Optional courses IILab.	--	02	--		01	---	01
TOTAL		**20**	**08**	**01**	**20**	**04**	**01**	**25**

Course Code	Course Name	Examination Scheme – Semester VI							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX601	Embedded System and RTOS	20	20	20	80	03	---	---	100
ELX 602	Computer Communication Network	20	20	20	80	03	---	---	100
ELX 603	VLSI Design	20	20	20	80	03	---	---	100
ELX 604	Signals and systems	20	20	20	80	03	25	25	100
ELXDLO602X	Department Level Optional courses II*	20	20	20	80	03	---	---	100
ELXL601	Embedded System and RTOS Lab.						25	25	50
ELXL 602	Computer Communication Network Lab.						25	25	50
ELXL 603	VLSI Design Lab.						25	25	50
ELXLDLO602 X	Department Level Optional Courses II*Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**125**	**750**

Course Code	Department Level Optional Course II
ELXDLO6021	Microwave Engineering
ELXDLO6022	Electronics Product Design
ELXDLO6023	Wireless Communication
ELXDLO6024	Computer Organization and Architecture

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703 X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Subject	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Lab.						25	25	50
ELXL702	Power Electronics Lab.						25	25	50
ELXL703	Digital signal processing Lab.						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703 X	Dept. Level Optional courses III Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELXL801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	**---**	**24**

Course Code	Course Name	Examination Scheme – Semester VIII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Lab.						25	25	50
ELXL802	Analog and Mixed VLSI Design Lab.						25	25	50
ELXL803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Lab.						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[#]
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 501	Microcontrollers and Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ELX 501	Microcontrollers &Applications	20	20	20	80	03	--	--	-	--	100

Course Code	Course Name	Credits
ELX 501	Microcontrollers and Applications	04
Course Objectives	To study 8-bit microcontroller architecture for system design along with exposure to advanced 32-bit architecture.	
Course Outcomes	1. Explain 8051 microcontroller architecture. 2. Develop assembly language programmes for 8051 microcontroller. 3. Design and implement 8051 based systems. 4. Explain advanced features of Cortex-M3 architecture.	

Module		Contents	Time
1.		**8051 Microcontroller Architecture**	04
	1.1	Introduction to microcontroller.	
	1.2	Overview of MCS51 family.	
	1.3	8051 architectural features.	
	1.4	Memory organisation.	
2.		**8051 Microcontroller assembly language programming**	10
	2.1	Addressing modes of 8051.	
	2.2	Instruction Set: Data transfer, Arithmetic, Logical, Branching.	
	2.3	Assembly Language Programming.	
3.		**8051 Internal Hardware & Programming**	10
	3.1	I/O port structure and programming.	
	3.2	Interrupts and programming.	
	3.3	Timer/Counter and programming.	
	3.4	Serial port and programming.	
4.		**8051 Interfacing & Applications**	12
	4.1	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric	

		LCD display.	
	4.2	Keyboard interfacing: 4x4 matrix keyboard.	
	4.3	Analog devices interfacing: 8-bit ADC/DAC, temperature sensor (LM35).	
	4.4	Motor interfacing: Relay, dc motor, stepper motor and servo motor.	
5.		**ARM CORTEX-M3 Architecture**	**12**
	5.1	Comparison of CISC & RISC architectures, overview of ARM family.	
	5.2	ARM Cortex-M3 architecture, Programmer’s model: Operation Modes and States, registers, special registers, Application Program Status Register-Integer status flags, Q status flag, GE bits.	
	5.3	Memory system: Features and memory map	
	5.4	Exceptions and Interrupts-Nested vectored interrupt controller	
		Total	**48**

Text books:

1.M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay,“The 8051 Microcontroller and Embedded Systems Using Assembly and C”, Pearson Education, 2ndEdition.

2.Joseph Yiu,“The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors”, Elsevier, 2014, 3rd Edition.

Reference Books:

1.Kenneth J. Ayala,“The 8051 Microcontroller”, Cengage Learning India Pvt. Ltd, 3rdEdition.

2.David Seal, “ARM Architecture”, Reference Manual (2nd Edition), Publisher Addison Wesley.

3.Andrew Sloss, Dominic Symes, Chris Wright,“ARMSystem Developers Guide: Designing and Optimising System Software”, Publisher Elsevier Inc. 2004.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.
4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 502	Digital Communication	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 502	Digital Communication	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering

Course Objectives:

The objectives of this course are to:

1. Understand the typical subsystems of a digital communication system
2. Understand the significance of the trade-off between SNR and Bandwidth
3. Understand the effect of ISI in Baseband transmission of a digital signal.
4. Analyze various Digital modulation techniques
5. Identify the necessity of Source encoding and Channel encoding in Digital communication

Course Outcomes:

On successful completion of the course the students will be able to:

1. Comprehend the advantages of digital communication over analog communication and explain need for various subsystems in Digital communication systems
2. Realize the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3. Understand the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect
4. Analyze various Digital modulation methods and assess them based on parameters such as spectral efficiency , Power efficiency, Probability of error in detection
5. Explain the concept and need for designing efficient Forward Error Correcting codes.
6. Realize the areas of application of Digital communication.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Digital communication system:**	06
	1.1	A typical Digital communication system, Advantages and disadvantages of Digital transmission, significance of digitization: PCM encoding of voice and image signals.	
	1.2	**Concept of Probability Theory in Communication Systems:** Random variables, Mean and Variance of Random variables and sum of random variables ,Definition with examples,	
	1.3	**Useful PDFs & CDFs** :Gaussian, Rayleigh pdf & Rician Distribution, Binomial Distribution, Poisson Distribution, Central-Limit Theorem, Binary Synchronous Channel(BSC), development of Optimal receiver	
2.		**Information Theory and Source Coding**	06
	2.1	Measure of Information, Entropy, Information rate, Channel capacity, Shannon – Hartley Capacity Theorem and its Implications.	
	2.2	Shannon-Fano encoding, Huffman encoding , Code Efficiency & Redundancy.	
3.		**Pulse Shaping for Optimum Transmission:**	08
	3.1	Line codes and their desirable properties, PSD of digital data	
	3.2	Baseband PAM transmission: Concept of Inter symbol interference(ISI),Raised Cosine filter , Nyquist Bandwidth. Concept of equalizer to overcome ISI	
	3.3	Correlative coding: Duo-binary encoding and modified duo-binary encoding	
4.0		**Digital Modulation Techniques**	14
	4.1	Concept of Binary and M-ary transmission, Coherent and Non- Coherent reception, Power spectral density of Pass-band signal, Signal space Representation and Euclidian distance	
	4.2	Pass Band Amplitude modulation & Demodulation: BASK , M-ary PAM ,Digital Phase Modulation & Demodulation: BPSK, OQPSK, QPSK, M-ary PSK, QAM , Digital Frequency Modulation &Demodulation :BFSK, MSK , M-ary FSK	
	4.3	Comparison of all techniques based on Spectral efficiency, Power efficiency, Probability of error in detection	
	4.4	**Optimal Reception of Digital Data**: A baseband signal receiver and its Probability of error, The Optimum receiver, Matched filter, & its properties.	
5.0		**Error Control codes:**	10
	5.1	Need for channel encoding, Concept of Error detection and correction , Forward Error	

		correction	
	5.2	**Linear block codes** : Hamming Distance, Hamming Weight, Systematic codes ,Syndrome Testing	
	5.3	**Cyclic codes**; Generator polynomial for Cyclic codes, Systematic cyclic codes, Feedback shift register for Polynomial division	
	5.4	**Convolution codes**: Convolution encoder , Impulse response of encoder, State diagram, trellis diagram Representations	
6.0		**Applications of Digital communication**	**06**
	6.1	**Satellite communication system** : Satellite communication System model, Transponder ,Satellite Orbits : LEO, MEO, GEO , Link analysis	
	6.2	**Optical Communication system** : Advantages of Optical communication ,Signal transmission in Optical fibres, Optical sources and Optical Detectors, Optical Digital Communication system.	
		Total	**48**

Recommended Text Books:

1. Simon Haykin, "*Communication System*", John Wiley And Sons ,4th Ed
2. Taub Schilling & Saha, "*Principles Of Communication Systems*", Tata Mc-Graw Hill, Third Ed
3. B P Lathi & Zhi Ding ,"*Modern Digital and Analog communication systems" -4E,* Oxford University Press , Indian Ed.
4. R N Mutagi, "*Digital Communication"*, Oxford University Press, 2nd Ed.

Reference Books:

1. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
2. Simon Haykin, "Digital communication", John wiley and sons
3. PROAKIS & SALEHI, "Communication system Engineering", Pearson Education.
4. Anil K.Maini & Varsha Agarwal, "Satellite communications", Wiley publication.
5. Amitabha Bhattacharya, "*Digital Communication*", Tata Mcgraw Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Course Objectives:

1. To study correlation between electrostatics, steady magnetic field and time varying fields using Maxwell's equations for different media.
2. To calculate energy transported by means of electromagnetic waves from one point to another and to study polarization of waves.
3. To solve electromagnetic problems using different numerical methods.
4. To extend the students' understanding about the propagation of the waves of different types.
5. To understand the radiation concepts.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze the behaviour of electromagnetic waves in different media.
2. Evaluate various parameters of transmission lines and radiating systems.
3. Apply computational techniques to analyze electromagnetic field distribution.
4. Understand different mechanisms of radio wave propagation.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Laws of Electromagnetic and Maxwell's Equations**	10
	1.1	Coulomb's law, Gauss's law, Bio-Savart's law, Ampere's law, Poisson's and Laplace equations	
	1.2	**Maxwell's Equations:** Integral and differential form for static and time varying fields and its interpretations	
	1.3	Boundary conditions for Static electric and magnetic fields	
2.0		**Electromagnetic Waves**	12
	2.1	Wave Equation and its solution in partially conducting media(lossy dielectric), perfect dielectrics, free space and good conductors, Skin Effect and concept of Skin depth	
	2.2	**Polarization of wave:** Linear, Circular and Elliptical	
	2.3	**Electromagnetic Power:** Poynting Vector and Power Flow in free space, dielectric and conducting media	
	2.4	**Propagation in different media:** Behavior of waves for normal and oblique incidence in dielectrics and conducting media, propagation in dispersive media	

3.0		**Computational Electromagnetics**	**06**
	3.1	**Finite Difference Method (FDM):** Neumann type and mixed boundary conditions, Iterative solution of finite difference equations, solutions using band matrix method	
	3.2	**Finite Element Method (FEM)**: triangular mesh configuration, finite element discretization, element governing equations, assembling all equations and solving resulting equations	
	3.3	**Method of Moment (MOM):** Field calculations of conducting wire	
4.0		**Fundamentals of Radiating Systems**	**06**
	4.1	Concept of retarded potentials, Lorentz Condition	
	4.2	Radiation from an alternating current element, half-wave dipole and quarter-wave monopole	
	4.3	**Antenna Parameters:** Radiation Patterns, beam-width, Radiation intensity, directivity, power gain, band-width, radiation resistance and efficiency, effective length and effective area	
5.0		**Radio wave propagation**	**06**
	5.1	**Types of wave propagation:** Ground, space, and surface wave propagation	
	5.2	**Space wave propagation:** Effect of imperfection of earth, curvature of earth, effect of interference zone, Line of sight propagation, troposphere propagation and fading	
	5.3	**Sky wave propagation:** Reflection and refraction of waves, structure of Ionosphere	
	5.4	**Measures of ionosphere propagation:** Critical frequency, Angle of incidence, Maximum usable frequency, Skip distance, Virtual height	
6.0		**Transmission Lines**	**08**
	6.1	Transmission Line parameters and equivalent circuit Transmission line equation and solution	
	6.2	**Secondary Parameters:** Propagation constant, characteristic impedance, reflection and transmission coefficient, Input Impedance, SWR, introduction to Smith chart	
		Total	**48**

Recommended Books:

1. W.H. Hayt, and J.A. Buck, "*Engineering Electromagnetics*", McGraw Hill Publications, 7th Edition, 2006
2. R.K. Shevgaonkar, "*Electromagnetic Waves*", TATA McGraw Hill Companies, 3rd Edition, 2009
3. Edward C. Jordan and Keth G. Balmin, "*Electromagnetic Waves and Radiating Systems*", Pearson Publications, 2nd Edition, 2006
4. Matthew N.D. Sadiku, "*Principles of Electromagnetics*", Oxford International Student 4th Edition, 2007
5. J.D. Kraus, R.J. Marhefka, and A.S. Khan, "*Antennas & Wave Propagation*", McGraw Hill Publications, 4th Edition, 2011

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pract	Tutorial	Total
ELX504	Design with Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Prac.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELX504	Design with Linear Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Electronic Devices and Circuits I and II

Course Objectives:

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate an understanding of fundamentals of integrated circuits.
2. analyze the various applications and circuits based on particular linear integrated circuit.
3. select and use an appropriate integrated circuit to build a given application.
4. design an application with the use of integrated circuit

Module No.	Unit No.	Topics	Hrs.
1	**Fundamentals of Operational Amplifier**		04
	1.1	Ideal Op Amp, characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, practical determination of op-amp parameters, single supply versus dual supply op-amp	
	1.2	Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier	
2	**Applications of Operational Amplifier**		12
	2.1	**Amplifiers:** Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier and application of Op-Amp in Transducer Measurement System with detail design Procedure. Single supply dc biasing techniques for inverting, non inverting and differential amplifiers.	
	2.2	**Converters:** Current to voltage converters, voltage to current converters, generalized impedance converter	
	2.3	**Active Filters:** First order filters, Second order active finite and infinite gain low pass, high pass, band pass and band reject filters.	
	2.4	**Sine Wave Oscillators:** RC phase shift oscillator, Wien bridge oscillator,	

		Quadrature oscillator.	
3	**Non-Linear Applications of Operational Amplifier**		10
	3.1	**Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector.	
	3.2	**Schmitt Triggers:** Inverting Schmitt trigger, non-inverting Schmitt trigger with adjustable threshold levels.	
	3.3	**Waveform Generators:** Square wave generator and triangular wave generator with duty cycle modulation**.**	
	3.4	**Precision Rectifiers:** Half wave and full wave precision rectifiers and their applications.	
	3.5	Peak Detectors, Sample & Hold Circuits, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	
4	**Data Converters**		06
	4.1	**Analog to Digital**: Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC, ADC0808/0809 and its interfacing	
	4.2	**Digital to Analog**: Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC, DAC0808 and its interfacing	
5	**Special Purpose Integrated Circuits**		08
	5.1	Functional block diagram, working, design and applications of Timer 555.	
	5.2	Functional block diagram, working and applications of VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380.	
6	**Voltage Regulators**		08
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	
		Total	**48**

Recommended Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. William D. Stanley, "*Operational Amplifiers with Linear Integrated Circuits* ", Pearson, 4th Edition
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.
4. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
5. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
6. R. P. Jain, "*Modern Digital Electronics*," Tata McGraw Hill, 3rd Edition.
7. Ron Mancini, "*Op Amps for Everyone*", Newnes, 2nd Edition.
8. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
9. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
10. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final internal assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory preferably objective type and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5011	Database Management System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELX DLO5011	Database Management System	20	20	20	80	--	--	--	100

Prerequisite:

Basic knowledge of Data structure.

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction Database Concepts:**	**4**
	1.1	Introduction, Characteristics of databases File system v/s Database system Users of Database system	4

	1.2	Data Independence DBMS system architecture Database Administrator	
2.0		**Entity–Relationship Data Model**	8
	2.1	The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation	
3.0		**Relational Model and relational Algebra**	8
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model	
	3.2	Relational Algebra – unary and set operations , Relational Algebra Queries.	
4.0		**Structured Query Language (SQL)**	12
	4.1	Overview of SQL Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	
	4.2	Set and string operations, aggregate function - group by, having.Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints	
	4.3	Triggers	
5.0		**Relational–Database Design**	8
	5.1	Pitfalls in Relational-Database designs , Concept of normalization Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF.	
6.0		**Transactions Management and Concurrency**	12
	6.1	Transaction concept, Transaction states, ACID properties Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	

	6.2	Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. Deadlock handling	
		Total	**52**

Text Books:

1. G. K. Gupta "Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, " Introduction to Database Management", Wiley Publication.
3. Sharaman Shah, "Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems ",TMH.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5012	Digital Control Systems	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5012	Digital Control Systems	20	20	20	80	03	--	--	--	100

Course Pre-requisite: ELX301: Mathematics III , ELX401: Mathematics IV, ELX406: Linear Control Systems

Course Objectives:

1. To introduce the discrete-time systems theory.
2. To introduce Z-transform methods in digital systems design.
3. To introduce modern state-space methods in digital systems design.

Course Outcomes : At the end of the course, the learner will have the ability to

1. Justify the need for digital control systems as well as understand sampling and reconstruction of analog signals.
2. Model the digital systems using various discretization methods and understand the concept of Pulse Transfer Function.
3. Analyze the digital control systems using classical techniques.
4. Analyze the digital control systems using modern state-space techniques.
5. Understand the concept of controllability and design the state feedback controllers.
6. Understand the concept of observability and design the state observers.

Module		Contents	Time
1.		**Basics of discrete-time signals and discretization**	**06**
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system.	
	1.2	Impulse sampling. Nyquist-Shannon sampling theorem, reconstruction of discrete-time signals (ideal filter)	
	1.3	Realizable reconstruction methods (ZOH and FOH). Transfer function of ZOH and FOH.	
2.		**Modelling of Digital Control System**	**10**
	2.1	Discretization Approaches: Impulse invariance, step invariance, bilinear transformation, finite difference approximation of derivative.	
	2.2	Z-transform revision and its equivalence with starred Laplace transform.	
	2.3	The pulse transfer function (PTF) and general procedures to obtain PTF.	
3.		**Stability Analysis and Controller Design via Conventional Methods**	**12**
	3.1	Mapping between s-plane and z-plane, stability analysis of digital systems	

		in z-plane. Effects of sampling frequency on stability.	
	3.2	Transient and steady-state analysis of time response, digital controller design using root-locus method.	
	3.3	Digital controller design using bode plots, digital PID controller.	
	3.4	Realization of digital controllers: direct programming, standard programming, series programming, parallel programming, ladder programming,	
4.		**State Space Analysis of Discrete-time Systems**	**08**
	4.1	Revision of continuous-time state-space models. Solution of continuous-time state-space equation. Discretization of continuous-time state-space solution and discrete-time state-space model.	
	4.2	Various canonical state-space forms for discrete-time systems and transformations between state-space representations.	
	4.3	Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transforms, Caley-Hamilton theorem, Diagonalization).	
5.		**Controllability and State Feedback Controller Design**	**06**
	5.1	Concept of controllability. Distinction between reachability and controllability in discrete-time systems.	
	5.2	Digital controller design using pole-placement methods. (Similarity transforms, Ackerman's formula).	
6.		**Observability and Observer Design**	**06**
	6.1	Concept of observability. Distinction between detectability and observability in discrete-time systems.	
	6.2	Observer design (prediction observer and current observer). Output feedback controller design. Introduction to separation principle.	
	6.3	Dead-beat controller design, dead-beat observer design.	
Total			**48**

Text books:

1. **Ogata Katsuhiko**, "Discrete-time Control Systems", Pearson, 2nd Edition, 1995.
2. **M. Gopal**, "Digital Control and State Variable Methods", Tata McGrow-Hill, 3rd Edition, 2003.

Reference Books:

1. **Gene Franklin, J. David Powell, Michael Workman**, "Digital Control of Dynamic Systems", Addison Wesley, 3rd Edition, 1998.
2. **B. C. Kuo**, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
3. **Chi-Tsong Chen**, "Linear System Theory and Design", Oxford University Press, USA, 1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5013	ASIC Verification	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5013	ASIC Verification	20	20	20	80	03	--	--	--	100

Course Pre-requisite: EXC303: Digital Circuits and Design, ELXL304: Object Oriented Programming Methodology Laboratory, ELX 404: Digital System Design

Course Objectives

1. To introduce the learner System Verilog concepts for verification.
2. To introduce the learner advanced verification features such as practical use of classes, randomization, checking and coverage.
3. To highlight the significance of verification in VLSI industry.

Course Outcomes

At the end of the course, the learner will have the ability to

1. Demonstrate an understanding of programmable devices and verification methodologies.
2. Exploit new constructs in SV and advanced ASIC verification techniques.
3. Create test benches for digital designs in system verilog.
4. Carry out verification of design successfully using simulators

Module		Contents	Time
1.		**Programmable Devices and Verilog**	08
	1.1	**Programmable Devices:** Architecture of FPGA, CPLD with an example of Virtex-7 and Spartan -6 family devices	
	1.2	**Verilog HDL:** Data types, expressions, assignments, behavioural, gate and switch level modelling, tasks and functions	
2.		**Verification Basics and Data Types**	12
	2.1	**Verification Basics:** Technology challenges, Verification methodology options, Test bench creation, test bench migration, Verification languages, Verification IP reuse, Verification approaches, Layered Testbench, Verification plans	
	2.2	**Data Types:** Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user defined structures, type conversion, enumerated types, constants, strings, expression width	
3.		**Procedural statements, test bench and Basic OOP**	12
	3.1	**Procedural Statements and Routines:** Procedural statements, tasks, functions and void functions, task and function overview, routine arguments, returning from a	

		routine, local data storage, time values **Connecting the Test bench and Design:** Separating the test bench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, top level scope, program-module interactions	
	3.2	**Basic OOP:** Class, Creating new objects, Object deal location, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public vs. local, building a test bench	
4.		**Randomization and IPC**	**10**
	4.1	**Randomization:** Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques	
	4.2	**Threads and Inter process Communication:** working with threads, disabling threads, inter process communication, events, semaphores, mailboxes, building a test bench with threads and IPC	
5.		**Assertions and Functional Coverage**	**06**
	5.1	**System Verilog Assertions:** Assertions in verification methodology, Understanding sequences and properties	
	5.2	**Functional Coverage:** Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options	
		Total	**48**

Text books:

1. **Chris Spear**, “System Verilog for Verification: A guide to learning the testbench language features”, Springer, 3rd Edition.
2. **Janick Bergeron**, “Writing Testbenches Using System Verilog”, Springer 2006.
3. **Stuart Sutherland, Simon Davidmann, and Peter Flake**, “System Verilog for Design: A guide to using system verilog for hardware design and modeling”, Springer, 2nd Edition.

Reference Books:

1. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, “SystemVerilog Assertions Handbook”, VhdlCohen Publishing, 3rd edition
2. S Prakash Rashinkar, Peter Paterson and Leena Singh, “System on Chip Verification Methodologies and Techniques”, Kluwer Academic, 1st Edition.
3. System Verilog Language Reference manual
4. Samir Palnitkar, ”Verilog HDL: A guide to Digital Design and Synthesis” second edition,Pearson – IEEE 1364-2001 compliant.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5014	**Biomedical Instrumentation**	04	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX DLO5014	**Biomedical Instrumentation**	20	20	20	80	03	--	--	--	--	100

Course Objectives

1. Introduce the learners to basic physiology and function of various systems in human body.

2. Introduce the learners to Diagnostic, Pathology, Life supportive equipment and latest imaging modalities in hospitals and healthcare industry.

3. Motivate learners to take up live projects with medical applications which will benefit the society at large.

Course Outcomes

- Have basic knowledge about the basic structure and functions of parts of cell, generation of action potential and various bioelectric potentials.
- Builds foundation of knowledge of physiological processes such as respiratory, cardiovascular, nervous and muscular systems in human body.
- Compare various methods used for measurement of various cardiac parameters such as blood pressure, blood flow, blood volume, cardiac output and heart sounds.
- Know the basic principle of analytical instruments and will have an over view of pathology laboratory equipments such as colorimeter, spectrophotometer, blood cell counter and auto-analyser.
- Have knowledge of life support equipments such as pacemaker, defibrillator, Heart lung machine, Haemodialysis machine and baby incubator along with safety limits of micro and macro shocks and understand the importance of electrical safety in hospital equipments.
  Have knowledge of imaging modalities such as X-ray, CT, MRI and Ultrasound.

Module		Contents	Time
1.		**Bio-Potential measurements**	**06**
	1.1	**Human Cell** Structure of Cell, Origin of Bio-potentials, Generation of Action Potentials,.	
	1.2	**Electrodes** Electrode-Electrolyte interface and types of bio-potential electrodes	
2.		**Physiological Systems and Related Measurement**	**12**
	2.1	**Cardiovascular system** Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias, Design of ECG amplifier, Heart sounds measurement.	

	2.2	**Nervous system** CNS and PNS: Nerve cell, Neuronal Communication, Generation of EEG and its measurement. Normal and abnormal EEG, Evoked potential. Electroencephalography: EEG measurements, Electrode-placement and Block diagram of EEG machine	
	2.3	**Respiratory system** Physiology of respiration and measurements of respiratory related parameters like respiration rate, Lung Volumes and capacities	
	2.4	**Muscular system** Typical Muscle fibre Action potential Electromyography: EMG measurement and block diagram.	
3.		**Cardio-Vascular measurements**	**08**
	3.1	Blood Pressure- Direct and Indirect types.	
	3.2	Blood Flow- Electromagnetic and Ultrasonic type.	
	3.3	Blood Volume- Plethysmography: Impedance, Capacitive and Photoelectric type	
	3.4	Cardiac Output- Fick's method, Dye-dilution and Thermo-dilution type.	
4.		**Analytical equipment**	**05**
	4.1	Beer Lambert's law, Principle of photometry.	
	4.2	Photo-colorimeter : Optical diagram	
	4.3	Spectrophotometer : Optical diagram	
	4.5	Blood cell counter : Coulter's counter	
	4.6	Auto-analyser : Schematic diagram	
5.		**Life-saving and Support equipment**	**09**
	5.1	Pacemaker- Types of Pacemaker, Modes of pacing and its applications.	
	5.2	Defibrillator-Types of fibrillations, Modes of operation, DC Defibrillators and their applications.	
	5.3	Heart-Lung machine: System-flow diagram and its Application during surgery.	
	5.4	Haemodialysis machine: Principle of operation and System-flow diagram.	
	5.5	Baby Incubator and its applications	
	5.6	**Patient safety** Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention	
6.		**Imaging techniques**	**08**
	6.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its applications	
	6.2	CT Scan- CT Number, Block Diagram, scanning system and applications.	
	6.3	MRI- Concepts and image generation, block diagram and its applications	
	6.4	Ultrasound Imaging- Modes of scanning and their applications	
		Total	**48**

Text books:

1. Handbook of Biomedical Instrumentation: R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet resources.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners need to solve total 4 questions.
Question No.1 will be compulsory and based on entire syllabus.
Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
ELXL 501	Microcontrollers & Applications Laboratory	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ELXL501	Microcontrollers &Applications Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 501 (Microcontrollers and Applications)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.**

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. Practical and Oral exam will be based on the entire syllabus.

Suggested experiments:

- Maximum three experiments in X – 51 assembly programming involving arithmetic, logical, Boolean, code-conversion etc operations.
- Minimum three experiments on interfacing of X – 51 based system with peripheral IC's (ADCs, DACs etc) peripheral actuators (relays, motors etc.) sensors (temperature, pressure etc.).

Suggested mini projects:

- Interfacing single LED/seven-segment display(SSD)/multiple-SSD with refreshing along-with some additional functional feature.
- Interfacing dot matrix LED for message display/ rolling message display.

- Interfacing IR emitter/receiver pair for time-period/speed calculations.
- Interfacing single key/4 – key/4 X 4 matrix keyboard with some additional functional feature.
- Motors – continuous, stepper, servo interfacing with speed(RPM) indication.
- Multi-function alarm clock using buzzer and LCD.
- Interfacing DAC and generating various waveforms.
- Ambient temperature indicator using LM 35 and 8-bit ADC 0808.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 502	Digital Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 502	Digital Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum Seven experiments need to be conducted, out of which at least THREE should be software-based (Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. (“Beyond the scope of the syllabus”.) Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+REPORT carry minimum of 10 marks

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested experiments based on Laboratory setups:

1. Line codes
2. Binary modulation techniques: BASK,BPSK,BFSK
3. M-ary modulation techniques: QPSK ,QAM
4. MSK

Suggested experiments based on software:

1. Simulation of PDF& CDF of Raleigh / Normal/ Binomial Distributions
2. Simulation of Eye pattern for PAM signal
3. Source encoding: Huffman coding for Binary symbols

4. Simulation of Shannon-Hartley equation to find the upper limit on the Channel Capacity
5. Channel Encoding: Linear Block code : code generation, Syndrome
6. Cyclic code-code generation, Syndrome
7. Channel encoding: Convolutional code-code generation from generator sequences
8. Simulation of BPSK/QPSK/BFSK Modulation
9. Simulation of Duo-binary encoder-decoder
10. Plot and compare BER curves for Binary/ M-ary modulation schemes
11. Simulation of error performance of a QPSK/BPSK/MSK Modulator

Suggested topics for presentation:

1. DTH
2. Digital Multiplexing
3. Satellite Launching vehicles: PSLV, GSLV
4. Digital TV
5. Digital Satellite system: VSAT
6. RFID

Any other related and advanced topics.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL504	Design With Linear Integrated Circuits Laboratory	-	2	--	-	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXL504	Design With Linear Integrated Circuits Laboratory	--	--	--	--	25	25		50

Term Work:

At least Six experiments based on the entire syllabus of Course ELX504 **(Design with Linear Integrated Circuits)** should be set to have well predefined inference and conclusion. Few computation/simulation based experiments are encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

A mini project based on the following topic or additional real time applications are encouraged. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

1. Experiment on op amp parameters
2. Experiment on design of application using op amp (Linear)
3. Experiment on implementation of op amp application e.g. oscillator
4. Experiment on non linear application (e.g. comparator) of op amp
5. Experiment on non linear application (e.g. peak detector) of op amp
6. Experiment on ADC interfacing
7. Experiment on DAC interfacing
8. Experiment on IC 555

9. Experiment on voltage regulator (Design)
10. Experiment on implementation of instrumentation system (e.g. data acquisition).

    The topic for the mini project in the course based on the syllabus of ELX505(Design with Linear Integrated Circuits)need to be application oriented.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5011	Database Management Systems Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5011	Database Management Systems Laboratory	--	--	--	--	25	--	25		50

At least **eight experiments** based on the entire syllabus of **ELXDLO5011 (Data Base Management System)** should be set to have well-defined inference and conclusion. The experiments should be student-centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) must perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	To analyse the sampling and reconstruction of analog signal.
2	To study various discretization approaches (Impulse Invariance, Step Invariance, Bilinear Transformation)
3	Study of time domain transient and steady-state performance and performance specifications.
4	Digital controller design using Root-locus method.
5	Modelling of discrete-time systems in state-space and conversion to various canonical forms.
6	Discrete-time system simulation in Simulink.
7	Study digital PID controller and its implementation in MATLAB and Simulink.
8	Controllability and Observability of discrete-time systems.

9	Pole placement controller design for discrete-time systems.
10	Design of deadbeat controller and observer.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5013	ASIC Verification	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5013	ASIC Verification	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5013 (ASIC Verification)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

List of Experiments:

1. Implementation of 4:1 Multiplexer in Verilog with
    a. Gate level Modeling
    b. Structural/ Dataflow Modeling
    c. Behavioral Modeling
2. Implementation of D flip flop (Asynchronous/ Synchronous/latch) using Verilog.
3. Experiment to practice creating dynamic arrays, associative arrays, and queues (Test a synchronous 8-bit x64K (512kBit) RAM).
4. Write a test plan and test bench for ALU Design.
5. Experiment to practice Procedural Statements and Routines using tasks, functions and do-while loops.
6. Create Interfaces to connect the Test bench and Design.
7. Threads & IPC: Implement the following counters

        i. UP counter
        ii. DOWN counter
        iii. Divide by 2 count As threads. Use Fork join, fork join_none, fork_joinany.
8. Threads & IPC - create dynamic processes (threads) and get familiar with interprocess communication using events, semaphore and mailb
9. Functional Coverage - write cover groups and get familiar with the coverage repor
   Verification of FIFO

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5013	Biomedical Instrumentation	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5013	Biomedical Instrumentation	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5014 (Biomedical Instrumentation)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	Study of X-ray Tubes
2	Design of active notch filter for line frequency
3	Design of general purpose amplifier for Bio potential measurement.
4	Design of Pacemaker using 555 timer.
5	Demonstration of Blood pressure measurement.
6	Demonstration of Electrocardiogram recording.
7	Demonstration of Electroencephalogram recording.
8	Demonstration of Electromyogram recording.
9	Demonstration of Photo-Colorimeter.
10	Demonstration of Spectrophotometer.

11	Demonstration of Auto-analyser.
12	Demonstration of Blood Cell counter.
13	Demonstration of D C Defibrillator (proto type).
14	Demonstration of Baby Incubator.
15	Demonstration of X Ray machine.
16	Demonstration of CT scanner.
17	Demonstration of MRI machine.
18	Demonstration of Ultrasound machine.

Course Code	Course Name	Teaching scheme			Credit assigned			
ELX 601	Embedded Systems& Real Time Operating System	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX 601	Embedded Systems& Real Time Operating System	20	20	20	80	03	--	--	--	--	100

Course Objectives

To study concepts involved in embedded hardware and software for systems realisation.

Course Outcomes At the end of the course, the learner will have the ability to

1. Identify and describe various characteristic features and applications of embedded systems.
2. Analyse and identify hardware for embedded systems implementation.
3. Analyse and identify various software issues involved in Embedded systems for real time requirements.
4. Analyse and explain the design life-cycle for embedded system implementation.

Module		Contents	Time
1.		**Introduction to Embedded Systems**	**04**
	1.1	Characteristics and Design metrics of Embedded system.	
	1.2	Real time systems:Need for Real-time systems, Hard-Soft Real-time systems.	
	1.3	Challenges in Embedded system Design: Power, Speed and Code density.	
		Embedded Hardware	**12**
2.	2.1	Embedded cores, Types of memories, Sensors (Optical encoders, Resistive) and Actuators (Solenoid valves, Relay/switch, Opto-couplers)	
	2.2	Power supply considerations in Embedded systems: Low power features-Idle & Power down mode, Sleep mode, Brown-out detection.	
	2.3	Communication Interfaces: Comparative study of serial communication interfaces (RS-232, RS-485), I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. Selection criteria of above interfaces. **(Frame formats of above protocols are not expected)**	
3.		**Embedded Software**	**14**
	3.1	Program Modelling concepts: DFG,FSM,UML	
	3.2	Embedded C-programming concepts (from Embedded system point of view): Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routine, Device drivers.	
	3.3	Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS, Foreground/Background processes, Interrupt latency, Task, Task states, Multi-tasking, Context switching, Task scheduling, Scheduling algorithms-Rate Monotonic Scheduling, Earliest Deadline First (with numericals), Inter-process communication: Semaphore, Mailbox, Message queues, Event timers, Task synchronisation- Shared data, Priority inversion, Deadlock. Memory Management	
	3.4	Introduction to µCOS II RTOS: Study of Kernel structure of µCOS II, µCOS II functions for Initialisation, Task creation, Inter-task communication and Resource management, Memory management	**08**
4.		**System Integration , Testing and Debugging Methodology**	**04**
	4.1	Embedded Product Design Life-Cycle (EDLC)	
	4.2	Hardware-Software Co-design	
	4.3	Testing & Debugging: Boundary-scan/JTAG interface concepts, Black-Box testing, White-Box testing, Hardware emulation, Logic analyser.	
5.		**Case Studies**	**06**
	5.1	Soft Real-time: Automatic Chocolate Vending machine using µCOS II RTOS- Requirements study, Specification study using UML, Hardware architecture, Software architecture	
	5.2	Hard Real-time: Car Cruise-Control using µCOS II RTOS- Requirements study, specification study using UML, Hardware architecture, Software Architecture	

Text books:

1.Dr. K.V. K. K. Prasad, “Embedded Real Time System: Concepts, Design and Programming”, Dreamtech, New Delhi, Edition 2014.
2.Jean J. Labrosse,“MicroC / OS-II The Real-Time Kernel”, CMP Books, 2011, Edition 2nd.
3. Rajkamal, “Embedded Systems: Architecture, Programming and Design”, McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
4. SriramIyer, Pankaj Gupta,“Embedded Real Time Systems Programming”, Tata McGraw Hill Publishing Company ltd., 2003.

Reference Books:

1.DavidSimon,“An Embedded Software Primer”, Pearson, 2009.
2.Jonathan W. Valvano, “Embedded Microcomputer Systems – Real Time Interfacing”, Publisher - Cengage Learning, 2012 Edition 3rd.
3.AndrewSloss, DomnicSymes, Chris Wright,“ARM System Developers Guide Designing and Optimising System Software”, Elsevier, 2004
4.FrankVahid, Tony Givargis,“Embedded System Design – A Unified Hardware/Software Introduction”, John Wiley & Sons Inc., 2002.
5.Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.
4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 602	Computer Communication and Networks	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 602	Computer Communication and Networks	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX502 Digital Communication

Course Objectives:

The objectives of this course are to:

1. Introduce networking architecture and protocols
2. Understand the various layers and protocols in the TCP/IP model
3. Recognize different addressing schemes, connecting devices and routing protocols
4. Select the required protocol from the application layer protocols

Course Outcomes:

On successful completion of the course the students will be able to:

1. Demonstrate understanding of networking concepts and required protocols
2. Analyze the various layers and protocols of the layered architecture
3. Evaluate different addressing schemes, connecting devices and routing protocols
4. Appreciate the application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	06
	1.1	Uses of computer networks. Topologies, LAN, MAN, WAN, Network topologies, **Addressing :** Physical / Logical /Port addressing, Protocols and Standards.	
	1.2	**Protocol Architecture:** Need of layered protocol architecture, Layers details of OSI, , Protocol Layers and Their Service Models	
	1.3	TCP/IP Model: Protocol suite, Comparison of OSI and TCP/IP	
2.		**Physical Layer**	08
	2.1	**Transmission Media:** Guided media like Coaxial, fiber, twisted pair, and Wireless media, Transmission Impairments. Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway	
	2.2	**Data communication model :** DTE, DCE, RS-232D Interface , Null Modem , **Multiplexing :** FDM , Synchronous TDM , Statistical TDM, ADSL , xDSL, Cable Modem	
3.		**Data Link Control**	08
	3.1	**Data link services:** Framing, Flow control, Error control, ARQ methods, Piggybacking	
	3.2	**High Level Data Link Control (HDLC):** HDLC configurations, Frame formats, Typical frame exchanges.	
	3.3	**Medium Access Control Protocols**: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.		**Network Layer**	14
	4.1	**Switching**: Switched Communication networks, Circuit switching Networks, , Circuit switching Concepts, Packet switching Principles: Virtual circuit switching and Datagram switching	
	4.2	**Routing in Packet Switching Networks:** Characteristics, Routing strategies, Link state Routing versus Distance vector Routing. Least-Cost Routing Algorithms: Dijkstra's Algorithm, Bellman Ford Algorithm.	
	4.3	**Internet Protocol:** Principles of Internetworking: Requirements, Connectionless Operation Internet Protocol Operation: IP packet, IP addressing, subnet addressing , IPv4, ICMP, ARP, RARP IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6)	
5.		**Transport Layer & Application Layer**	08
	5.1	**Connection –oriented Transport Protocol Mechanisms: Transmission Control Protocol (TCP):** TCP Services, TCP Header format, TCP three way handshake, TCP state transition diagram.	

		User datagram Protocol (UDP)	
	5.2	**Congestion:** Effects of congestion, Congestion control methods, Traffic management, Congestion control in Packet switching Networks	
	5.3	**Application layer Protocols** : HTTP, FTP, DNS,SMTP, SSH	
6.		**LANs.** High speed Ethernet	**04**
	6.1	LAN Protocol architecture , LAN topologies, Hub, Bridges, Virtual LANs **Traditional Ethernet and IEEE 802.3 LAN Standard**: Ethernet protocol, Frame structure, Physical layers,	
	6.2	**High Speed Ethernet** : Fast Ethernet, Gigabit Ethernet & 10- Gigabit Ethernet	
		Total	**48**

Recommended Text Books

1. William Stallings, “Data and Computer communications”, Pearson Education, 10th Edition.
2. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
3. Alberto Leon Garcia, “Communication Networks” , McGraw Hill Education, Second Edition

Reference books :

1. S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition.
2. J. F. Kurose and K. W. Ross ,”Computer Networking: A Top-Down Approach”, Addison Wesley, 5th Edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 603	VLSI Design	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 603	VLSI Design	20	20	20	80	-	--	--	100

Prerequisite Subject:

- ELX302: Electronics Devices and Circuits- I
- ELX304: Digital Circuit Design
- ELX404: Digital System Design
- ELX504: Design with Linear Integrated Circuits

Course Objectives:

1. To study MOS based circuit realization using different design styles
2. To highlight the fundamental issues in data path and system level design

Course Outcomes: After successful completion of the course student will be able to …

1. Demonstrate a clear understanding of choice of technology, scaling, MOS models and system level design issues.
2. Design and analyze MOS based inverters.
3. Design MOS based circuits with different design styles.
4. Design semiconductor memories, adders and multipliers.

Unit No.	Details	Teaching Hours
1	**Technology Trend :** **1.1 Technology Comparison:** Comparison of BJT and MOS technology **1.2 MOSFET Scaling:** Types of scaling, Level 1 and Level 2 MOSFET Models, MOSFET capacitances	06
2	**MOSFET Inverters:** **2.1 Types of MOS inverters:** Active and passive load and their comparison. **2.2 Circuit Analysis of MOS Inverters:** Static Analysis resistive and CMOS inverter: Calculation of all critical voltages and noise margins. Design of symmetric CMOS inverter. Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay **2.3Logic Circuit Design:** Analysis and design of 2-I/P NAND,NOR and complex Boolean function using equivalent CMOS inverter for simultaneous switching.	10
3	**MOS Circuit Design Styles:**	10

	3.1 Design Styles: Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS, C^{2}MOS, Dynamic, Domino,NORA and Zipper. **3.2Circuit Realization:** Basic gates,SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX using above design styles.	
4	**Semiconductor Memories:** **4.1 SRAM:** 6T SRAM, operation, design strategy, leakage currents, read/write circuits, sense amplifier. **4.2DRAM**: 1T_DRAM, operation modes, leakage currents, refresh operation, physical design. 4.3 **ROM Array**: NAND and NOR PROM, Nonvolatile read/write memories-classification and programming techniques	08
5	**Data Path Design:** **5.1 Adder:** CLA adder, MODL, Manchester carry chainand high speed adders like carryskip, carry select and carry save. **5.2 Multipliers and shifter:** Array multiplier and barrel shifter	04
6	**VLSI Clocking and System Design:** **6.1Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution **6.2Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling **6.3I/O pads and Power Distribution:** ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme **6.4Interconnect:** Interconnect delay model, interconnect scaling and crosstalk.	10

Text and Reference Books	
	1.Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition. 2. John P. Uyemura, "Introduction to VLSI CIRCUITS AND SYSTEMS",Wiley India Pvt. Ltd. 3. Jan M. Rabaey, Anantha Chandrakasan and BorivojeNikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition. 4. Etienne Sicard and Sonia Delmas Bendhia, "*Basics of CMOS Cell Design*", Tata McGraw Hill, First Edition. 5. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition. 6. Debaprasad Das, "*VLSI Design*", Oxford, 1st Edition. 7. Kaushik Roy and Sharat C. Prasad, "*Low-Power CMOS VLSI Circuit Design*", Wiley, Student Edition. 8. David A Hodges, Horace G Jackson and Resve A Saleh, "Analysis and Design of Digital Integrated Cicuits", TMH, 3rd Edition
Additional Study Material & e-Books	
	1.Douglas A Pucknell, Kamran Eshraghian , "Basic VLSI Design", Prentice Hall of India Private Ltd. 2.Samir Palnitkar, " A Guide to Digital Design and Synthesis", Pearson Education

Subject Code	**Subject Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ELX604	**Signals and Systems**	**04**	**--**	**#01**	**04**	**--**	**01**	**05**

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Ave. Of Test 1 and Test 2**					
ELX604	**Signals and Systems**	**20**	**20**	**20**	**80**	**25**	**-**	**-**	**125**

#Class wise

Course Objectives:

1. To provide a comprehensive coverage of continuous time and discrete time Signals and Systems.
2. To introduce various time domain and frequency domain methods for analysis of Signals and systems.

Course Outcomes:

After successful completion of this course student will be able to

1. Differentiate between continuous time and discrete time Signals and Systems.
2. Understand various transforms for time domain to frequency domain conversion
3. Apply frequency domain techniques for analysis of LTI systems
4. Apply frequency domain techniques for analysis of continuous and discrete signals

Module No.	**Unit No.**	**Topics**	**Hrs.**
1.		**Continuous and Discrete Time Signals**	**8**
	1.1	Mathematical Representation and Classification of CT and DT signals, Orthogonality of signals	
	1.2	Arithmetic operations on the signals, Time Shifting, Time scaling, Time Reversal of signals	
	1.3	Sampling and Reconstruction, Aliasing effect	
2		**Continuous and Discrete Systems**	**8**
	2.1	Mathematical Representation and classification of CT and DT systems	
	2.2	Properties of LTI systems, impulse and step response.	
	2.3	Use of convolution integral, convolution sum and correlation for analysis of LTI systems	
	2.4	Properties of convolution integral and convolution sum	
3		**Frequency Domain Analysis of Continuous Time System using Laplace Transform**	**6**
	3.1	Concept of Complex frequency, Region of Convergence for Causal, Non-causal and Anti-causal systems, Poles and Zero of transfer function	
	3.2	Unilateral Laplace Transform	
	3.3	Analysis and characterization of LTI system using Laplace Transform: Impulse and Step Response, Causality, Stability, Stability of Causal system	
4		**Frequency Domain Analysis of Discrete Time System using Z Transform**	**12**
	4.1	Need for Z transform, definition, properties of unilateral and bilateral Z Transform, mapping with s plane, relationship with Laplace transform	
	4.2	Z transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform	
	4.3	Analysis and characterization of LTI system using Z transform: impulse and step response, causality, stability, stability of causal system	
	4.4	System realization-Direct, Direct Canonic, Cascade and Parallel forms	
5		**Frequency Domainc Analysis of Continuous Signals**	6
	5.1	Frequency Domain Analysis of periodic non-sinusoidal signals	
	5.2	Frequency Domain Analysis of aperiodic Signals-Introduction, Properties of Fourier Transform, Fourier Transform based amplitude and phase response of standard signals, Relationship with Laplace and Z transform, Energy Spectral	
6		**Frequency Domain Analysis of Discrete Signals**	8
	6.1	Discrete Time Fourier Series, Evaluation of DTFS coefficients, Magnitude and Phase Spectrum of Discrete time periodic signals, Power Spectral Density	
	6.2	Discrete Time Fourier Transform – Concept of discrete time signal in frequency domain, definition of DTFT, determination of magnitude and phase functions using DTFT	
		Total	**48**

Text Books:

1. Tarun Kumar Rawat, "*Signals and Systems*", Oxford University*Press 2016.*
2. A. NagoorKani, *"Signals and Systems"*, Tata McGraw-Hill Education

Reference Books:

1. John Proakis and DimitrisMonolakis, "*Digital Signal Processing*", Pearson Publication, 4th Edition
2. Alan V. Oppenheim, AlanS. Willsky, and S.Hamid Nawab, "*Signals and Systems*", 2nd Edition, PHIlearning,2010.
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press,

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO6021	Microwave Engineering	04	--	#01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX6021	Microwave Engineering	20	20	20	80	25	-	-	125

Prerequisites: Knowledge of basic Engineering Electromagnetics

Course Objectives:

1. To introduce the students to various concepts of Microwave Engineering.
2. To teach the students the working principles and applications of different microwave devices.

Course Outcomes (CO):

After successful completion of the course, students will be able to:

1. Understand the importance and applications of microwaves.
2. Explain the process of generation and amplification of microwaves.
3. Analyse the electromagnetic field distribution in various microwave components.
4. Measure various microwave parameters.

Module	Contents	Hours
1	**Introduction to microwave communication** 1.1 Microwave spectrum and bands 1.2 Limitations of conventional circuit theory concepts at microwave frequencies 1.3 Applications of microwaves 1.4 Limitations of conventional vacuum tubes at microwave frequencies	4
2	**Generation and amplification of microwaves** 2.1 **Two cavity Klystron amplifiers:** Construction , Process of velocity modulation and bunching , Apple gate diagram Output power and efficiency , Applications 2.2 **Reflex Klystron:** Construction ,Process of velocity modulation and bunching	12

	Apple gate diagram , Output power and efficiency Applications 2.3 **Cylindrical Magnetron** Construction and working principle Hull cut-off magnetic equation , Cyclotron angular frequency Applications 2.4 **Traveling wave tube**: construction and working principle applications 2.5 numerical examples based on the above topics	
3	**Waveguides:** 3.1 Rectangular and circular waveguides 3.2 solution of Maxwell's equation for distribution of fields in the waveguides 3.3 characteristic equation 3.4 Dominant and degenerate modes 3.5 group and phase velocities 3.6 cut-off frequency 3.7 numerical examples based on the above topics	10
4	**Waveguide components and analysis**: 4.1 Definition and significance of s-parameters 4.2 Properties of s-parameters 4.3 Construction, working principle and s-matrix representation of cavity resonators, waveguide attenuators, waveguide phase shifters, waveguide multiport junctions, E-plane and H-plane Tees, Magic Tee, Hybrid Ring, direction couplers 4.4 Microwave ferrite components: Faraday rotation isolator, Circulator, Gyrator Numerical examples based on the above topics	12
5	Microwave solid state devices: 5.1Principle of operation and characteristics of: Gunn Diode, TRAPATT and IMPATT diodes, Microwave Transistors 5.2 Introduction to Strip Lines	5
6	Microwave Measurement: Measurement of 6.1 Power 6.2 Attenuation 6.3 Frequency 6.4 VSWR 6.5 Cavity Q 6.6 Impedance	5

Text Books:

1. “ Microwave Devices and Circuits” by Samuel Liao, PHI
2. “Microwave circuits and Passive Devices” by M L Sisodia, G S Raghuvanshi, New Age International(P) Ltd

Reference Books:

1. “ Electronic Communication Systems” by Kennedy, Davis, 4e TMH
2. “ Microwave Engineering: Passive Circuits” by Peter Rizzi, PHI
3. “ Foundations for Microwave Engineering” by Robert E Collin, 2e, John Wiley
4. “ Basic Microwave Techniques & Laboratory Manual” by M L Sisodia, G S Raghuvanshi, 2001 New Age International(P) Ltd
5. Microwave Engineering, Annapurna Das, TMH\

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6022	Electronic Product Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX DLO6022	Electronic Product Design (EPD)	20	20	20	80	---	---	100

Rationale :- The aim of this course is to enable students to gain practical experience & nurture their creativity in electronic product design & the objective is to provide students with a clear understanding of the practical design problems of the electronic products at an introductory level. With this course, students are expected to become familiar with the concept of designing a product as per the requirements (non-technical) & given specifications (technical), component tolerances, production constraints, safety requirements & EMC standards.

Course Objectives:-

1. To understand the stages of product (hardware / software) design & development

2. To learn different considerations of analog, digital & mixed circuit design

3. To be acquainted with methods of PCB design & different tools used for the same

4. To be aware of the importance of testing in product design cycle

5. To gain knowledge about various processes & importance of documentation

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Design electronic products using user-centered designing processes
- **CO-2 :-** Identify & recognize essential design & production procedures of electronic products
- **CO-3 :-** Implement a prototype for meeting a particular requirement / specification
- **CO-4 :-** Demonstrate problem solving & troubleshooting skills in electronic product design
- **CO-5 :-** Prepare the relevant set of design documentation & present it as a case study

Module No.	Topics	Hours
1	**INTRODUCTION TO ELECTRONIC PRODUCT DESIGN**	06
	Man-machine dialog & industrial design, user-centered design, elements of successful design, cognition, ergonomics, packaging & factors; design for manufacture, assembly & disassembly wiring, temperature, vibration & shock; safety, noise, energy coupling, grounding, earthing, filtering & shielding	
2	**HARDWARE DESIGN & TESTING METHODS**	10
	Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design, functional model v/s architectural model, prototyping, performance & efficiency measures, formulating a test plan, writing all the specifications, test procedures & test cases, design reviews, module debug & testing – black box testing, white box testing, grey box testing	
3	**SOFTWARE DESIGN & TESTING METHODS**	10
	Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention, software bugs & testing, good programming practice, user interface, embedded & real-time software	
4	**PRINTED CIRCUIT BOARD (PCB) DESIGNING**	08
	Fundamental definitions, standards, routing topology configuration, layer stack up assignment, grounding methodologies, aspect ratio, image planes, functional partitioning, critical frequency & bypassing, decoupling; design techniques for ESD protection, guard-band & guard-rings	
5	**PRODUCT DEBUGGING & TESTING**	08
	Steps of debugging, the techniques for troubleshooting, characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components, inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	
6	**THE DOCUMENTATION PROCESS**	06
	Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents, methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual, fault finding tree, software documentation practices	
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
2. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
3. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press
4. G. C. Loveday, Electronic Testing & Fault Diagnosis, 4th edition, A. H. Wheeler Publishing
5. James K. Peckol, Embedded Systems – A Contemporary Design Tool, 1st edition, Wiley Publication
6. J. C. Whitaker, The Electronics Handbook, CRC Press

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6023	Wireless Communication	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX DLO6023	Wireless Communication	20	20	20	80	-	--	--	100

Course Objectives:

The objectives of this course are to:

1. To introduce the Concepts of basic Cellular communication systems , mobile Radio propagation
2. To understand the various Cellular processes such as handoff strategies, interference, Trunking theory
3. To study the features and services of 2G cellular technologies: GSM and CDMA
4. To study the features of evolving technological advances in 2G, 3G & 4G Cellular systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Understand the concepts of basic cellular system, frequency reuse, channel assignment
2. Understand the fundamentals radio propagation , Path loss and comprehend the effect of Fading .
3. Acquire the Knowledge about multiple access technologies and different of different spread spectrum techniques.
4. Acquire the Knowledge about overall GSM cellular concept and analyse its services and features
5. Comprehend the features of CDMA technology
6. Analyse the evolution of cellular technology from 2G to 4G Cellular systems .

Module No.	Unit No.	Topics	Hrs.
1.		**Concept of Cellular Communication**	08
	1.1	Introduction to cellular communications, Frequency reuse, Channel assignment strategies	
	1.2	**Cellular Processes:** Call setup, Handoff strategies, interference and system capacity, Co-channel Interference reduction with the use of Directional Antenna	
	1.3	**Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity in Cellular systems: Cell splitting, Sectoring, Micro-cell Zone concept	
2.		**Mobile Radio Propagation**	08

	2.1	Introduction to Radio wave propagation, Free space propagation model, the three basic Propagation mechanisms, The Ground Reflection (two-ray) model, Practical Link budget design using Path-Loss models:Log-distance Path –loss model.	
	2.2	Small scale Multipath Propagation: Factors influencing small scale fading, Doppler shift, Parameters of mobile multipath channels,	
	2.3	Types of small scale fading, Fading effects due to Doppler spread, Fading effects due to Multipath Time delay spread, Raleigh and Rician distributions	
3.0		Multiple access techniques & Spread spectrum Modulation	**08**
	3.1	Multiplexing and Multiple Access:Time Division Multiple Access, Frequency Division Multiple Access, Spread-spectrum multiple-access:Code Division Multiple Access	
	3.2	Spread spectrum Modulation :Need for and concept of spread spectrum modulation, PN-sequence generation, properties of PN-sequence, Gold sequence generation, Direct-sequence SS, Frequency-hopping SS,	
4.0		**GSM**	**12**
	4.1	GSM network architecture, Signalling protocol architecture, Identifiers, Physical and Logical Channels, Frame structure, Speech coding, Authentication and security, Call procedure, Hand-off procedure, Services and features	
5.0		**IS-95**	**06**
	5.1	Frequency and channel specifications of IS-95, Forward and Reverse CDMA channel, Packet and Frame formats, Mobility and Resource management	
6.0		**Evolution from 2G to 4G**	**06**
	6.1	GPRS, EDGE technologies, 2.5G CDMA-One cellular network, W-CDMA (UMTS), CDMA2000, LTE, Introduction to 5G Networks	
		Total	**48**

Recommended Books:

6. Theodore Rappaport, “Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
7. ITI Saha Misra, “Wireless Communication and Networks: 3G and Beyond”, Publication
8. Vijay Garg, “IS-95 CDMA and cdma 2000: Cellular/PCS System Implementation”, Pearson Publication.

Reference Books:

1. T.L Singal , “Wireless Communication”, Tata McGraw Hill ,2010
2. Upena Dalal , “Wireless Communication”, Oxford University Press, 2009
3. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
4. Vijay Garg, “Wireless communication and Networking”, Pearson Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
ELX DLO6024	Computer Organization and Architecture	**Theory**	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
		04	**--**	**--**	**04**	**--**	**--**	**04**

Course Code	Course Name	Examination Scheme									
		Theory					**Term work**	**Pract.**	**Oral**	**Pract / Oral**	**Total**
		Internal Assessment			**End sem**	**Duration (hrs)**					
		Test 1	**Test 2**	**Avg**							
ELX DLO6024	Computer Organization and Architecture	**20**	**20**	**20**	**80**	**03**	**--**	**--**	**--**	**--**	**100**

Course Objectives	1. To introduce the learner to the design aspects which can lead to maximized performance of a Computer. 2. To introduce the learner to various concepts related to Parallel Processing 3.To highlight the various architectural enhancements in modern processors.
Course Outcomes	At the end of the course, the learner will have the ability to 1. Define the performance metrics of a Computer 2.Explain the design considerations of Processor, Memory and I/O in Computer systems 3. Explain the advantages and limitations of Parallelism in systems 4. Explain the various architectural enhancements in modern processors

Module		Contents	Time
1.		**Introduction to Computer Organization**	**[06]**
	1.1	Fundamental Units of a Computer	01
	1.2	Introduction to Buses	01
	1.3	Number Representation methods- Integer and Floating-point, Booth's Multiplier, Restoring and Non-Restoring Division	03
	1.4	Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	01
2.		**Processor Organization and Architecture**	**10**
	2.1	CPU Architecture , Register Organization, Instruction cycle, Instruction Formats	04
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	04
	2.3	Comparison between CISC and RISC architectures	02
3.		**Memory Organization**	**12**
	3.1	Classification of Memories-Primary and Secondary Memories, RAM (SRAM and DRAM) and ROM (EPROM , EEPROM), Memory Inter-leaving	02
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency (* Numerical Problems expected)	06
	3.3	Virtual Memory Management-Concept, Segmentation , Paging, Page Replacement policies	04
4.		**Input/Output Organization**	**06**
	4.1	Types of I/O devices and Access methods, Types of Buses , Bus Arbitration	03
	4.2	Expansion Bus Concept, PCI Bus	03
5.		**Parallelism**	**06**
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, Amdahl's law	02
	5.2	Pipelining - Concept, Speedup, Efficiency , Throughput, Types of Pipeline hazards and solutions (* Numerical Problems expected)	04
6.		**Architectural Enhancements**	**08**
		Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, Non-Uniform Memory Access (NUMA) systems, Vector Computation , GPU	08

Text books:

1.William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.

2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.

Reference Books:

1. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

2. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.

3. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann,1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.

The Learner need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ELXL 601	**Embedded Systems& Real Time Operating System Laboratory**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					**Term work**	**Pract.**	**Oral**	**Pract. / Oral**	**Total**
		Internal Assessment			**End sem**	**Duration (hrs)**					
		Test 1	**Test 2**	**Avg**							
ELXL 601	**Embedded Systems& Real Time Operating System Laboratory**	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 601 (Embedded System & Real Time Operating System)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

- Simulation experiments using KeilC–cross complier to: evaluate basic C program for X-51 assembly; evaluating various C data types; evaluating and understanding iterative C constructs translated into x51's assembly; evaluating and understanding interrupt implementation.
- Simulate and understand working of µCOS-II functions using example programs from recommended text,"MicroC / OS-II The Real-Time Kernel", by Jean J. Labrosse.
- Porting of µCOS-II on X-51/AVR/CORTEX M3 platform.

Subject Code	**Subject Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/Practical**	**Tutorial**	**Total**
ELXL 602	Computer Communication and Networks Laboratory	-	2	--	-	01	--	01

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Ave. Of Test 1 and Test 2**					
ELXL 602	Computer Communication and Networks Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum **Seven experiments** need to be conducted, out of which **at least Four Experiments** should be software-based (C/C++ , Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. ("Beyond the scope of the syllabus".)

Power point presentation should contain minimum of 15 slides and students should submit a report (PPT+Report)carry minimum of 10 marks . The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of experiments:

1. Study of transmission media and interconnecting devices of communication networks.
2. Implementation of serial transmission using RS232
3. Implementing bit stuffing algorithm of HDLC using C/C++
4. Implementation of Routing protocols using C/C++
5. Study of NS2 simulation software
6. Implementation of TCP/UDP session using NS2
7. Implementation of ARQ methods using NS2
8. Study of WIRESHARK and analyzing Packet using WIRESHARK
9. Study and implementation of IP commands
10. Study of GNS software and implementation of routing protocols using GNS

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 603	VLSI Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL 603	VLSI Design Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 603 (VLSI Design)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

MOSFET Scaling using circuit simulation software like Ngspice
Static and transient performance analysis of various inverter circuits
Implementation of NAND and NOR gate using various logic design styles
Design and verification of CMOS Inverter for given static and transient performance
Implementation of ROM, SRAM, DRAM
Interconnect analysis

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6021	Microwave Engineering Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6021	Microwave Engineering Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELXDLO 6021 (Microwave Engineering)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6022	Electronic Product Design	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6022	Electronic Product Design	--	--	--	--	--	25	--	--	25	50

At least **Six** experiments based on the entire syllabus of **ELXDLO6022 (**Electronic Product Design**)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Lab session includes **six experiments plus one presentation on case study.**

Suggested Experiments:

1. Experiment based on Ground and Supply bounce
2. PCB design steps involved in product design
3. Simulation based on use of Simulator software
4. Working of an Emulator in Design step
5. Role of Pattern Generator in Design step
6. Debugging of the digital circuit based on Logic Analyzer
7. Application of the Spectrum analyzer
8. Demonstration of usefulness of the Arbitrary waveform generator
9. Setup for EMI and EMC test
10. Experiment based on calibration of the product.

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL DLO6023	Wireless Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL DLO6023	Wireless Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes seven experiments and a Case study(Power point Presentation)on any one of the suggested topics.

Note:

1. The experiments will be based on the syllabus contents.

2. Minimum seven experiments need to be conducted.(Scilab, MATLAB, LabVIEW, NS2/NS3 etc can be used for simulation).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work.

The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology.

(“Beyond the scope of the syllabus”.)

Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+Report) carry minimum of 10 marks The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6024	Computer Organization and Architecture	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6024	Computer Organization and Architecture	--	--	--	--	--	25	--	--	25	50

At least **six** experiments based on the entire syllabus of **ELX DLO6024 (Computer Organization and Architecture)** should be set to have well-defined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Additionally, a **Seminar on IEEE/ACM paper** focussing on key areas of research in Computer Architecture/Organization to be part of the term-work which is duly graded. **Suggested List of Experiments:**

Expt. No.	Title of the Experiments
1	Implementation of Booth's Algorithm (using VHDL)
2	To create a control store for micro-programmed control unit (using VHDL)
3	Using a cache simulator , calculate the cache miss-rate for various mapping schemes
4	Implement various page replacement policies (LRU, FIFO,LFU)
5	Program to detect the type of hazard (RAW,WAR,WAW)for a set of instructions
6	Using a performance analyzer tool, extract various performance metrics

B.E. (Electronics Engineering)

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELX801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	---	**24**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 701	Instrumentation System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX 701	Instrumentation System Design (ISD)	20	20	20	80	---	---	100

Rationale :- For optimum operation & satisfactory performance of any industrial process control system, it is necessary to have a reliably engineered system with a thorough knowledge of the process conditions & requirements as per the system or design specifications. This subject introduces various nuances in the design of instrumentation systems, which is itself a synergy of sensors, transducers, actuators, process control & electronic systems to achieve the desired operation of a plant or the proper control of an industrial process. Students are exposed to principles of designing which enable them to design, build & implement such electronically controlled systems for measurement, signal conditioning & final control.

Course Objectives :-

1. To learn basic functions & working of pneumatic, hydraulic & electrical components used in process control
2. To understand principles of process parameter conversion & transmission in various forms
3. To gain familiarity with control system components & their applications in process control
4. To study various types of controllers used in process control & their tuning for different applications
5. To be aware of recent advances & technological developments in industrial instrumentation & process control

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **ELX 701.1 :-** Demonstrate the needs of advancement in instrumentation systems
- **ELX 701.2 :-** Select the proper components for pneumatic & hydraulic systems
- **ELX 701.3 :-** Choose the transmitter / controller for given process application
- **ELX 701.4 :-** Analyze the controller parameters for discrete or continuous type
- **ELX 701.5 :-** Design the controller (electronic) for a given process or application

Module No.	Topics	Hours
1	**ACTUATORS & PROCESS CONTROL VALVES**	**08**
1.1	Electrical actuators – relays, solenoids & electrical motors (DC, AC & stepper motor)	
1.2	Pneumatic actuators – basic pneumatic system, pneumatic compressors (piston, vane, screw) flapper nozzle, single & double acting cylinder, rotary actuator, filter-regulator-lubricator (FRL)	
1.3	Hydraulic actuator – hydraulic pumps, control valves types (globe, ball, needle, butterfly, gate, diaphragm & pinch), cavitation & flashing with their remedies, pressure drop across valve & leakage, valve noise, flow characteristics on load changes, control valves parameters, control valves sizing, valve calibration, digital control valves, selecting control valves & applications	
2	**DESIGN OF SIGNAL CONDITIONING CIRCUITS**	**08**
2.1	Principles of analog & digital signal conditioning – signal level & bias change, linearization, conversion, filtering & impedance matching, concept of loading, comparators & converters	
2.2	Design of operational amplifier based circuits in instrumentation – analysis of voltage divider circuits, bridge circuits, RC filters, inverting & non-inverting amplifier, instrumentation amplifier, V to I & I to V converter, integrator, differentiator & linearization (with numerical examples)	
2.3	Transmitters – Introduction to telemetry & its basic block diagram, 2 wire, 3 wire & 4 wire transmitters, 4 mA to 20 mA current transmitter, electronic transmitters for temperature, level, pressure & flow, current to pressure (I to P) & pressure to current (P to I) converters	
3	**PROCESS CONTROLLER PRINCIPLES**	**08**
3.1	Discontinuous controller – two position mode, multi-position mode & floating mode	
3.2	Continuous controller – single mode (P, I & D) & composite mode (PD, PI & PID), split range, auto select, ratio & cascaded controllers, selection criterion of controller for a process mode	
3.3	Tuning of PID controller – process loop tuning, open loop transient response method, Ziegler – Nichols tuning method, frequency response methods (numerical examples on PID tuning)	
4	**PROGRAMMABLE LOGIC CONTROLLERS (PLC)**	**10**
4.1	Discrete state process controller – discrete state variables, process specifications & event sequence description	
4.2	Relay controller & ladder diagram – introduction to relay ladder diagram logic, ladder diagram elements & ladder diagram programming examples	

4.3	PLC – relay sequencers, programmable logic controller design, PLC operation, programming the PLC, PLC software functions (application examples on relay ladder logic programming)	
5	**DIGITAL BASED PROCESS CONTROL**	**08**
5.1	Data acquisition system (DAS) – objectives, signal conditioning of inputs, single channel DAS, multi-channel DAS, computer based DAS, data logger, difference between DAS & data logger	
5.2	Computer aided process control – architecture, human machine interface (HMI), supervisory control & data acquisition (SCADA), standard interfaces (RS-232C, RS-422A & RS-485)	
5.3	Supervisory control system (SCS), introduction to the Fieldbus & Profibus process controlled networks, overview of distributed control system (DCS), features & advantages of DCS	
6	**CALIBRATION STANDARDS & ADVANCES IN INSTRUMENTATION**	**06**
6.1	PC & microcomputer based instrumentation, virtual instrumentation & LabVIEW introduction	
6.2	Calibration of instrumentation systems, representation of instrumentation control process with SAMA & ISA symbols, ISO/IEC 17025 General requirements for calibration standards	
6.3	Instrumentation standards, ISA S82.01 – Safety Standard for Electrical and Electronic Test, Measuring, Controlling Related Equipment, ISA S84.01 – Application of Safety Instrumented Systems for the Process Industries, ANSI/NEMA 250 – Enclosures for Electrical Equipment	
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. Curtis D. Johnson, Process Control Instrumentation Technology, 7th edition, PHI
2. S. K. Singh, Industrial Instrumentation & Control, 3rd edition, McGraw Hill
3. B.C. Nakra & K. K. Chaudhary, Instrumentation Measurement & Analysis, 3rd edition, McGraw Hill
4. Andrew Parr, Pneumatics & Hydraulics, 2nd edition, Jaico Publishing Co.
5. B. G. Liptak, Handbook of Process Control & Instrumentation, 4th edition, CRC Press
6. William C. Dunn, Fundamentals of Industrial Instrumentation & Process Control, 1st edition, McGraw Hill

Internal Assessment (IA) :-Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX702	Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	ExaminationScheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX702	Power Electronics	20	20	20	80	03	--	--	--	100

\Course Pre-requisite:

1. ENAS
2. EDC-1
3. EDC-2

Course Objectives:

1. To teach power electronic devices and their characteristics.
2. To highlight power electronics based rectifiers, inverters and choppers.

Course Outcomes:

After successful completion of the course students will be able to:

1. Discuss trade-offs involved in power semiconductor devices.
2. Design of triggering, commutation and protection circuits for SCRs.
3. Analyse different types of single-phase rectifiers and DC-DC converters.
4. Analyse different types of DC-AC converters (inverters).
5. Analyse different types of AC Voltage Controllers and Cycloconvertors.

Module No.	Unit No.	Contents	Hrs.
1		**Power semiconductor devices**	8
	1.1	Principle of operation of SCR, static and dynamic characteristics, gate Characteristics,	
	1.2	Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC, MOSFET and power BJT. IGBT: basic structure, principle of operation, equivalent circuit, latch-up in IGBT's and V-I characteristics.	
2		**SCR: Triggering, commutation and Protection Circuits**	8
	2.1	Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine),	
	2.2	Design of commutation circuits,	
	2.3	Protection of SCR	
3		**Single-phase Controlled Rectifiers**	8
	3.1	Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	
	3.2	Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.	
	3.3	Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HF/THD), Crest Factor (CF)), output performance parameters.	
4		**Inverters**	10
	4.1	Introduction to basic and improved series/parallel inverters, limitations.	
	4.2	Introduction, principle of operation, performance parameters of Single phase half / full bridge voltage source inverters with R and R-L load,	
	4.3	Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications	
5		**DC-DC converters**	8
	5.1	Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators (CCM mode only)	
	5.2	Voltage commutated, current commutated and load commutated DC-DC	

		converters	
	5.3	Applications in SMPS, Battery charging systems.	
6		**AC Voltage Controllers and Cycloconvertors**	**6**
	6.1	Principle of On-Off control, principle of phase control, single phase bidirectional control with R and RL load	
	6.2	Introduction, single phase and three phase Cyclo-converters, applications	
		Total	**48**

Recommended Books:

1. M. H. Rashid, “*Power Electronics*”, Prentice-Hall of India
2. Ned Mohan, “*Power Electronics*”, Undeland, Robbins, John Wiley Publication
3. P. S. Bhimbra, “Power Electronics”, Khanna Publishers, 2012
4. M.D. Singh and K. B. Khanchandani, “*Power Electronics*”, Tata McGraw Hill
5. Ramamurthy, “ *Thyristors and Their Applications*”
6. P. C. Sen, “*Modern Power Electronics*”, Wheeler Publication
7. S. Shrivastava, “Power Electronics”, Nandu Publication, Mumbai.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 and Test 2					
EXC703	**Digital Signal Processing**	**20**	**20**	**20**	**80**	**--**	**--**	**--**	**100**

Prerequisite Courses: Signals and Systems

Course Objectives:

1. To teach the design techniques and performance analysis techniques of digital filters
2. To introduce the students to advanced signal processing techniques, digital signal processors and applications

Course Outcomes:

After successful completion of this course students will be able to

1. Demonstrate an understanding of the discrete-time Fourier transform and the concept of digital frequency.
2. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
3. Understand the effect of hardware limitations on performance of digital filters
4. Use advanced signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform and Fast Fourier Transform**	**10**
	1.1	Definition and Properties of DFT,IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT Filtering of long data sequences: Overlap Save and Overlap Add Method Computation of DFT	
	1.2	Fast Fourier transforms(FFT),Radix-2decimationintime and decimation in frequency FFT algorithms, inverse FFT, and Introduction to composite FFT	
2.0		**IIR Digital Filters**	**10**
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band stop and All Pass) Analog filter approximations: Butterworth, Chebyshev I and II	
	2.2	MappingofS-planetoZ-plane,impulseinvariancemethod,bilineartransformation method, Design of IIR digital filters from analog filters with examples	
	2.3	Analog and digital frequency transformations with design examples	
3.0		**FIR Digital Filters**	**10**
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zero sof linear phase FIR filters	

	3.2	Design of FIR filter susing window techniques (Rectangular, Hamming, Hanning,Blackmann, Barlet) Design of FIR filter susing Frequency Sampling technique Comparison of IIR and FIR filters	
4.0		**Finite Word Length Effects in Digital Filters**	**06**
	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling	
	4.2	Quantization in Floating Point realization of IIR digital filtersFinite word length effects in FIR digital filters	
5.0		**Multirate DSPand FilterBanks**	**06**
	5.1	Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer numbers Multistage Approach to Sampling rate converters	
	5.2	Sample rate conversion using Polyphase filter structure, Type I and Type II Polyphase Decomposition	
6.0		**DSP Processors and Applications**	**06**
	6.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator(MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism	
	6.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware	
	6.3	Applications of DSP: Radar Signal Processing and Speech Processing	
Total			**48**

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing"*, A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, " *Digital Signal Processing"*, Oxford University Press, 2015

Reference Books:

1. ProakisJ., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
2. Sanjit K. Mitra , Digital Signal Processing – A Computer Based Approach – edition 4e
3. McGraw Hill Education (India) Private Limited
4. OppenheimA.,SchaferR.,BuckJ.,"*DiscreteTimeSignalProcessing*",2ndEdition, Pearson Education..
5. B. VenkataRamaniand, M. Bhaskar, "*Digital Signal Processors, Architecture, Programming andApplications*", Tata McGraw Hill, 2004.
6. L.R.RabinerandB.Gold,"*TheoryandApplicationsofDigitalSignalProcessi*ng",Prentice-HallofIndia, 2006.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5markswill be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	20	20	20	80	-	--	--	100

Pre-requisite

- Knowledge of linear algebra, multivariate calculus, and probability theory
- Knowledge of a programming language (MATLAB /C/C ++ recommended)

Course Objectives:

- To study basics of biological Neural Network.
- To understand the different types of Artificial Neural Networks
- To know the applications of ANN .
- To study fuzzy logic and fuzzy systems.

Course outcomes:

At the end of completing the course of Neural Networks & Fuzzy Logic, a student will be able to:

1. Choose between different types of neural networks
2. Design a neural network for a particular application
3. Understand the applications of neural networks
4. Appreciate the need for fuzzy logic and control

Module	Contents	Hours
1	**Introduction:**1.1 Biological neurons, McCulloch and Pitts models *of* neuron, Types of activation function, Network architectures, Knowledge representation, Hebb net 1.2 Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning 1.3 Learning Rules : Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner-Take-All Learning Rule 1.4 Applications and scope of Neural Networks	**10**
2	**Supervised Learning Networks :** 2.1 Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent, – least mean square algorithm, Linear & non-linear separable classes & Pattern classes, 2.2 Back Propagation Network, 2.3 Radial Basis Function Network.	**12**
3	**Unsupervised learning network:** 3.1 Fixed weights competitive nets, 3.2 Kohonen Self-organizing Feature Maps, Learning Vector Quantization, 3.3 Adaptive Resonance Theory – 1	**06**
4	**Associative memory networks:** 4.1 Introduction, Training algorithms for Pattern Association, 4.2 Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, 4.3 Discrete Hopfield Networks.	**08**
5	Fuzzy Logic: 5.1 Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence 5.2 Fuzzification and Defuzzification 5.3 Fuzzy Controllers	**12**

TOTAL	**48**

Text- Books:

- Dr. S. N. Sivanandam, Mrs S.N. Deepa, *"Principles of Soft computing"*, Wiley Publication.
- Jacek M. Zurada, *"Introduction to Artificial Neural Systems,* Jaico publishing house.

Reference books :

- Simon Haykin, "*Neural Network* a - *Comprehensive Foundation",* Pearson Education.
- S. Rajsekaran, Vijaylakshmi Pai, *"Neural Networks, Fuzzy Logic, and Genetic Algorithms"*, PHI.
- Thimothy J. Ross, "*Fuzzy Logic with Engineering Applications",* Wiley Publication.
- Christopher M Bishop, *"Neural Networks For Pattern Recognition"* ,Oxford Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of total 6 questions, each of 20 marks.
2. Only 4 questions need to be solved.
3. Question number 1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.
5. No question should be asked from pre-requisite module

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7032	Advanced Networking Technologies	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7032	Advanced Networking Technologies	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX602 Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:

The objectives of this course are to:

1. Understand the characteristic features of Various Wireless networks
2. Understand Optical networking and significance of DWDM.
3. Introduce the need for network security and safeguards
4. Understand the principles of network management

Course Outcomes:

On successful completion of the course the students will be able to:

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM)
3. Understand the features of emerging wireless Networks: Bluetooth Networks,ZIGBEE, WSN
4. Analyze the importance of Optical networking
5. Demonstrate knowledge of network design and security and management
6. Understand the concept of Cloud Computing and its applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Wireless LAN and WAN technologies**	**08**
	1.1	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations .	
	1.2	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM	

		cells , ATM Functional Layers, Congestion control and Quality of service	
2.		**Emerging Wireless Technologies**	**10**
	2.1	**Wireless Personnel Area Network(WPAN):** WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	2.2	802.15.3- Ultra Wide Band , 802.15.4- Zigbee , RFID	
	2.3	**Wireless Sensor Networks: Introduction and Applications,** Wireless Sensor Network Model, Sensor Network Protocol Stack,	
3.0		**Optical Networking**	**08**
	3.1	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	3.2	DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations	
4.0		**Network Design, Security and Management**	**10**
	4.1	3 tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	
	4.2	Network Security: Security goal, Security threats, security safeguards, firewall types and design.	
	4.3	Network management definitions, functional areas (FCAPS), SNMP,RMON	
5.0		**Routing in the Internet:**	**06**
	5.1	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	5.2	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
6.0		**Cloud computing:**	**06**
	6.1	Cloud Computing Evolution, Definition, SPI framework of Cloud Computing, Cloud service delivery models,	
	6.2	Cloud deployment models, key drivers to adoption of cloud, impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.	
		Total	**48**

Recommended Text Books:

1. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
2. Darren L. Spohn , “Data Network Design” , McGraw Hill Education ,Third edition
3. William Stallings, “Data and Computer communications”, Pearson Education, 10th Edition.
4. Tim Mather , Subra Kumaraswamy & Shahed Latif, “Cloud security & Privacy: an enterprise Perspective”, O’Reilly Media Inc.Publishers

Reference Books:

1. William Stallings, “Wireless Communications and Networks”, Pearson Ed., 2nd Edition.

2. Vijay Garg ,"Wireless Communication and networking" , Morgan Kaufmann Publishers
3. Carr and Snyder, " Data communication and network security" , McGraw Hill ,1ST edition.
4. Upena Dalal & Manoj Shukla , " Wireless Communication and Networks", Oxford Press
5. Deven Shah , Ambavade, "Advanced Communication Networking"
6. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7033	Robotics	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7033	Robotics	20	20	20	80	-	--	--	100

Pre-requisite: Applied Mathematics III, Applied Mathematics IV ,Linear Control Systems

Course Objectives:

1. To study basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3 To familiarize students with Trajectory & task planning of robots.

4 To familiarize students with robot vision

Course outcomes:

At the end of completing the course of Robotics, a student will be able to:

1. understand the basic concepts of robotics
2. perform the kinematic and the dynamic analysis of robots
3. perform trajectory and task planning of robots
4. describe importance of visionary system in robotic manipulation

Module	Contents	Hours
1	**Fundamentals of Robotics:** 1.1 Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	**04**
2	**Kinematics of Robots:** 2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation 2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	**10**
3	**Velocity Kinematics & Dynamics:** 3.1 **Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities, 3.2 **Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot	**10**
4	**Trajectory planning:** 4.1 Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	**08**
5	**Robot Vision:** 5.1 Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration	**08**
6	**Task Planning:** 6.1 Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	**08**
	TOTAL	**48**

Text- Books :

- Robert Shilling, “Fundamentals of Robotics - Analysis and contro”l, Prentice Hall of India, 2009
- Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011

Reference books :

- John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
- Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
- Mikell P. Groover et.al, ”Industrial Robots-Technology, Programming & applications”, McGraw Hill , New York, 2008

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	**Subject Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/Practical**	**Tutorial**	**Total**
ELXDLO7034	**IC Technology**	04	--	--	04	--	--	04

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Avg. of Test 1 and Test 2**					
ELXDLO7034	**IC Technology**	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ELX302:Electronic Devices and Circuits I
- ELX303:Digital Circuit Design
- ELX603:VLSI Design

Course Objectives:

1. To provide knowledge of IC fabrication processes and advanced IC technologies.
2. To disseminate knowledge about novel VLSI devices and materials.

Course Outcomes:

After successful completion of the course student will be able to

1. Demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Crystal Growth, Wafer preparation and fabrication for VLSI Technology**	8
	1.1	**Semiconductor Manufacturing:** Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering.	
	1.2	**Semiconductor Substrate:** Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	12
	2.1	**Epitaxy:** Classification, Molecular Beam Epitaxy	
	2.2	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of	
		Silicon Dioxide, Oxide Quality.	
	2.3	**Device Isolation:** LOCOS, Shallow Trench Isolation (STI).	
	2.4	**Deposition: Physical Vapor Deposition-**Evaporation and Sputtering, **Chemical Vapor Deposition:** APCVD, LPCVD,PECVD	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion.	
	2.5	**Ion Implantation:** Penetration range-Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	
3.0		**Fabrication Process Part 2**	12
	3.1	**Etching &Lithography:** **Etching:** Basic concepts and Classification **Lithography:** Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.2	**Metallization and Contacts:** Introduction to Metallization, Schottky contacts and Ohmic contacts.	
	3.3	**CMOS Process Flow:** N well, P-well and Twin tub, CMOS Latch Up	
	3.4	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried	

		and Butting Contact	
4.0		**Measurement and Testing**	06
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility,	
	4.2	**Testing:** Technology trends affecting testing, VLSI testing process and test	
		equipment, test economics and product quality	
		VLSI Technologies	05
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD SOI and FD SOI Device structure and their features	
	5.2	**Advanced Technologies:** low κ and high κ, BiCMOS, HκMG Stack, Strained Silicon.	
	5.3	**GaAs Technologies:** MESFET Technology, MMIC technologies, MODFET	
		Novel Devices and Materials	
	6.1	**Multigate Devices:**Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). **Nanowire:** Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires.	05
	6.2	**2-D Materials and FET:**Graphene& CNT FET, MOS2 and Black Phosphorous.	
		Total	**48**

Recommended Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.
2. Stephen A. Campbell, "*The Science and Engineering of Microelectronic Fabrication"*, Oxford University Press, 2nd Edition.
3. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "*Fundamentals of Semiconductor Fabrication*", Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, "*SOI Circuit Design Concepts",* Kluwer Academic Publishers, 1st edition.

6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors",* Springer, 1st edition
7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1st edition.
8. James E. Morris and KrzysztolIniewski, "*Nanoelectronic Device ApplicationsHandbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press
10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing fordigital, memory and mixed-signal VLSI circuits*", Springer

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, “Taguchi Technique for Quality Engineering,” McGrawHill
7. Madhav S Phadke, “ Quality Engineering using Robust Design,” Prentice Hall

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem,	14

	Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication

8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	**Course Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/Practical**	**Tutorial**	**Total**
ELXL701	Instrumentation System Design Laboratory	---	02	---	04	---	---	04

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Oral & Practical**	**Total**
		Internal Assessment (IA)			**End Semester Examination**			
		Test I	**Test II**	**Average**				
ELXL701	Instrumentation System Design Laboratory	---	---	---	---	25	25	50

Term Work :-

At least 06 experiments covering entire syllabus of ELX 701 (Instrumentation System Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments :-

1. Study of pneumatic single acting & double acting cylinder
2. Study of hydraulic process control valves
3. Design of stepper motor interface & controller
4. Design of instrumentation amplifier for variable voltage gain
5. Design of signal conditioning circuits for LDR / thermistor / RTD / strain gauge
6. Design of linearization circuits for transducers
7. Design of temperature P+I+D controller
8. Tuning of P+I+D controller using MATLAB / Simulink
9. Implementation of PLC ladder diagram for given application
10. Study of SCADA & HMI
11. Designing of data acquisition system (DAS)
12. Simulating a simple process using LabVIEW

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL702	Power Electronics	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL702	Power Electronics	---	---	---	---	25	25	50

Term Work :-

At least 06 experiments covering entire syllabus of ELX 702 (Power Electronics) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of Experiments

1. Characteristics of SCR, DIAC, TRAIC.
2. Characteristics of IGBT, MOSFET and Power BJT.
3. Firing circuit for SCR using UJT.
4. Study of Half wave and Full wave rectifiers using diodes.
5. Study of Half wave and Full wave controlled rectifiers.
6. Buck converter, Boost converter and Buck-Boost converter.
7. Study of Cycloconverter.
8. Simulation of single phase Half wave and Full wave rectifier circuit.
9. Simulation of controlled rectifier with R and RL load.
10. Simulation of controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL703	Digital Signal Processing	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL703	Digital Signal Processing	---	---	---	---	25	25	50

Instructions

1. Minimum 6 experiments and one course project must be submitted by each student.
2. Simulation tools like Matlab/Scilab can be used.
3. Processor based experiments/mini projects can be included.
   The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Tentative List of Experiments:

1. Study of Convolution, Series and Parallel Systems
2. Generation of Basic Signals
3. Computation of DFT and it's inverse
4. Computation of FFT and comparison of frequency response of DFT and FFT
5. Computation of DFT
6. IIR Butterworth filter design using IIT technique
7. IIR Chebyshev filter design using BLT technique
8. Design of FIR filter using hamming and hanning window, low pass and high pass filter

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	---	---	---	25	25	50

Term Work:

The term work shall consist of

1. At least ***six experiments*** using MATLAB Or C/C++ or Java covering the whole of syllabus, duly recorded and graded.
2. ***One seminar and Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using C/C++ or Matlab or java

- Activation functions
- McCulloch Pitts Neuron Model
- Hebbian learning
- Single layer perceptron neural network
- Multi-layer perceptron neural network

- Error Back propagation neural network
- Kohonen Self-organizing Feature Maps
- Associative memory network
- Fuzzy relations
- Defuzzification methods

Suggested List of seminar :

- Classification of upper case and lower case letters.
- Classification of numbers 0-9.
- BPN for training a hidden layer.
- Implement a heteroassociative memory network to implement any pattern.
- Implement discrete Hopfield network for letters A-E.
- Implement BAM for a pattern of 5X3 array.
- Fuzzy Logic controller design – washing machine / vehicle speed control.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/Practical**	**Tutorial**	**Total**
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Ave. Of Test 1 and Test 2**					
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

1. Evaluation of home/campus network
2. GSM-GPS protocol implementation
3. Bluetooth protocol implementation
4. ZigBee protocol implementation
5. Wi-Fi protocol implementation
6. Study of NMAP
7. Study of SNMP
8. Study of Ethernet.

Suggested topics for presentation:

1. MANET
2. VOFR
3. VOIP
4. X.25
5. Body area network
6. RFID
7. Web Security
8. Compression Techniques
9. Security attacks
10. NAT
11. College campus network

12. Fiber Optics types, advantages disadvantages
13. WSN

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7033	Robotics	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7033	Robotics	-	-	-	-	25	--	25	50

Term Work:

The term work shall consist of

3. At least ***eight experiments*** using MATLAB / Scilab covering the whole of syllabus, duly recorded and graded.
4. ***Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using Matlab / Scilab

- Forward kinematics
- Inverse kinematic
- Dynamic analysis
- Joint-space trajectory
- Cartesian-space trajectory
- Template matching
- Iterative processing
- Segmentation

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7034	IC Technology	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7034	IC Technology	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

Following list of experiments covers the complete syllabus prescribed in IC Technology course. It is formulated in such a way that it allows student to explore various process, layout and device simulation tools. Detail analysis of observations should be recorded in the project book. Tools to be used are Microwind, SUPREME, Electric, Visual TCAD, Mentor Graphics Pyxis and tools available on nanohub. Linux based operating system is preferred to do simulations.

1. Draw and simulate layout for the CMOS inverter. Carry out static as well as transient simulation. Analyze CMOS inverter for i) $(W/L)_{pmos}>(W/L)_{nmos}$ ii) $(W/L)_{pmos}=(W/L)_{nmos}$ iii) $(W/L)_{pmos}<(W/L)_{nmos}$. Do parasitic extraction. Feed these parasitic in circuit simulator and do layout versus schematic verification.

2. Draw and simulate layout for the following circuits. Size them with respect to reference inverter.

   a. CMOS NAND
   b. CMOS NOR

Also observe the effect of different types of design rules on above circuits and tabulate the comparative results.

3. Draw and simulate layout for the given equation (each student will get different equation [$y=\overline{A.B + C.D}$]) with the following design style

   a. Static CMOS
   b. Transmission gate
   c. Dynamic Logic

4. Draw and simulate layout for 6T SRAM cell. Size the SRAM cell for 1) lowest area 2) high reliability

5. Draw and simulate layout for the following circuits.

a. SR latch

b. D flip Flop

6. Simulate oxidation process with Deal-Grove model for different conditions (e.g. oxidation type, orientation, time, temperature, thickness etc.) and comment on the results obtained.

7. Simulate diffusion process for different conditions (e.g. source, time, temperature, dopant etc.) and comment on the results obtained.

8. Simulate Si PN junction for various structure and environmental conditions and comment on the results obtained. Repeat the entire simulation for Ge diode.

9. Simulate MOS capacitor (Classical Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

10. Simulate MOS capacitor (Quantum Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

Suggested topics for presentation:

Presentation on any Novel device or process.

B.E. (Electronics Engineering) – Semester VIII

`Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 801	Internet of Things	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 801	Internet of Things	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX 501 :- Micro-controllers and Applications
ELX 601:- Embedded System and RTOS
ELX602:- Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:

The objectives of this course are to:

1. Understand the design features of Internet of Things(IoT)
2. Understand importance of data handling in IoT Way.
3. Introduce multiple way of data communication and networking.
4. Understand design issue in IoT

Course Outcomes:

On successful completion of the course the students will be able to:

1. Understand the concepts of Internet of Things
2. Analyze basic web connectivity in IoT
3. Understand Data handling in IoT
4. Design basic applications based on IoT using specific components

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to IoT**	08
	1.1	**Introduction;-**Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, and M2MCommunication.	
	1.2	**Iot and M2m:-** IoT/M2M System layers and Design Standardization, Difference between IoT and M2M	
2.		**Network & Communication aspects**	10

	2.1	**Design Principles & Web Connectivity:-** Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets (Publish –Subscribe),MQTT, AMQP, CoAP Protocols	
	2.2	**Internet Connectivity: -** Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals :LORA ,NBIoT,CAT LTE M1,SIGFOX	
3.0		**IoT Platforms and Design Methodology**	**08**
	3.1	**Defining Specifications About:-** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, (case studies)	
	3.2	**IoT Levels:-**IoT Levels and Deployment Templates	
4.0		**Data Handling in IoT**	**10**
	4.1	**Data Acquiring, Organizing, Processing:-** Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	
	4.2	**Data Collection and Storage:-** Cloud Computing Paradigm for Data Collection, storage and computing, Cloud Service Models, Xively Cloud for IoT (AWS ,Google APP engine ,Dweet.IO, Firebase)	
5.0		**Components of IoT**	**06**
	5.1	**Exemplary Devices:-** Raspberry Pi, R-Pi Interfaces, Programming R-Pi, Sensor Technology, Sensor Data Communication Protocols, RFID, WSN Technology, Intel Galileo	
6.0		**IoT Case Studies**	**06**
	6.1	Design Layers, complexity, IoT Applications in Premises, Supply Chain and Customer Monitoring.	
	6.2	Home Automation, Smart Cities, Environment, Agriculture, IoT Printer	
		Total	**48**

Recommended Text Books:

5. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
6. Raj Kamal, “ Internet of Things: Architecture and Design Principles”, McGraw Hill Education ,First edition
7. David Hanes ,Gonzalo salgueiro“IoT Fundamentals Networking Technologies,Protocols and Use Cases for Internet of Things”, Cisco Press, Kindle 2017 Edition
8. Andrew Minteer ,”Analytics for the Internet of Things(IoT)”,Kindle Edition

Reference Books:

1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things”, Paperback, First Edition
2. Yashavant Kanetkar , Shrirang Korde :Paperback “21 Internet of Things (IOT) Experiments”
    a. BPB Publications

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of thesyllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	T/W Practical	Tutorial	Total
ELX802	Analog and Mixed VLSI Design	04	02	-	04	-	-	04

		Examination Scheme								
		Theory Marks				Exam Duration (Hrs)	Term work	Practical	Oral	Total
		Internal Assessment Marks			End Sem Exam (Marks)					
		Test 1	Test 2	Average						
ELX802	Analog and Mixed VLSI Design	20	20	20	80	03	-	-	-	100

Course Pre-requisite:

- ELX302: Electronic Devices and Circuits I
- ELX303: Digital Circuit Design
- ELX402: Electronic Devices and Circuits II
- ELX504: Design With Linear Integrated Circuits
- ELX603: VLSI Design
- ELX DLO-3: IC Technology

Course Objectives:

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.
3. To emphasize upon the issues related to mixed signal layout design.

Course Outcomes:

After successful completion of the course student will be able to

1. Discuss tradeoffs involved in analog VLSI Circuits.
2. Analyze building blocks of CMOS analog VLSI circuits.
3. Design building blocks of CMOS analog VLSI circuits
4. Carry out verifications of issues involved in analog and mixed signal circuits

Module No	Unit No	Topics	Hrs
1. 0		**Analog building blocks**	8
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks,current mirror.	
	1.2	**Voltage References:** Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT	

		current generation and Constant Gm biasing	
2.0		**Amplifier Fundamentals**	
	2.1	**Single Stage Amplifiers**: Basic concepts, Gain Bandwidth (GBW), Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage.	12
	2.2	**Differential Amplifiers:** Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.	
	2.3	**Noise:** Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise in differential pairs, noise bandwidth, noise figure, noise temperature.	
3.0		**MOS Operational Amplifiers**	
	3.1	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps	8
	3.2	**Op-amp Design:** General Considerations, performance parameters, One-stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations(ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps	
4.0		**Mixed Signal Circuits**	
	4.1	**Basic Concepts:** AMS design flow, ASIC, Full custom design, Semi-custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	8
	4.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO,	
	4.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
5.0		**Data Converter Fundamentals**	
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non- inverting amplifier and integrator.	4
	5.2	Basic CMOS comparator Design, Adaptive biasing, Analog multipliers.	
6.0		**Data Converter Fundamentals and Architectures**	
	6.1	**Fundamentals:** Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	8
	6.2	**DAC architectures:** Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC **ADC architectures:** Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs	
		Total	**48**

Recommended Books:

1. B Razavi, "*Design of Analog CMOS Integrated Circuits*", Tata McGraw Hill, 1st Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, "*CMOS Circuit Design, Layout, and Simulation*", Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, "*CMOS Analog Circuit Design*", Oxford University Press, 3rd Edition.
4. Gray, Meyer, Lewis, Hurst, "*Analysis and design of Analog Integrated Circuits*", Willey, 5th Edition

Internal Assessment (IA)

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8041	Advanced Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8041	Advanced Power Electronics	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

4. Power Electronics.
5. Linear Control System.
6. BEE

Course Objectives:

3. To enhance the ideas of students for more complex power electronic system.
4. To teach the analytical methods in power electronic systems.
5. To expose the students to various applications of power electronics in electronics equipment, drives and non-conventional energy systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Thoroughly understand the modern methods of analysis and control of power electronic systems.
2. Carry out the theoretical analysis of the power electronic systems from the ‘Systems Theory’ point of view.
3. Appreciate the ubiquity of power electronic systems in engineering fields.
4. Simulate and analyse power electronic systems.

Module No.	Unit No.	Contents	Hrs.
1		**Three-phase Rectifiers**	**8**
	1.1	3-phase half-wave and full-wave controlled rectifiers with R and RL load, Effect of source inductance,	
	1.2	Distortion in line current, calculation of performance parameters.	
2		**Three-phase inverters and control**	**8**
	2.1	Three phase bridge inverters (120°and 180° conduction mode) with R and RL load	
	2.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
3		**DC-DC Converters**	**10**
	3.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters.	
	3.2	Feedback control of these converters (PI and PID).	
4		**Power Electronic Applications in DC Drives**	**8**
	4.1	Introduction to DC motors, speed control of DC motor, drives with semi converters, full converters and dual converters.	
	4.2	Chopper-based drive.	
	4.3	Electric braking of DC motors.	
5		**Power Electronic Applications in AC Drives**	**10**
	5.1	Introduction to three-phase induction motor, speed control methods for three-phase induction motor : i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Slip power recovery schemes	
6		**Power Electronic Applications**	**4**
	6.1	Induction heating, dielectric heating, solid state relays,	

	6.2	Energy conversion interface in renewable energy system.	
Total			**48**

Recommended Books:

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3rd Edition.
2. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2nd Edition.
3. Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2nd Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2nd Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8042	MEMS Technology	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8042	MEMS Technology	20	20	20	80	03	--	--	--	100

Course Pre –requisite: VLSI Design an IC Technology

Course Objectives:

1. To provide knowledge of MEMS processing steps and processing modules
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and structures.

Course Outcomes:

1. Understand the underlying fundamental principles of MEMS devices including physical operation and material properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of micro system sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

Module No.	**Unit No.**	**Contents**	**Hrs.**
1		**Introduction to MEMS**	**4**
	1.1	Introduction to MEMS, Comparison with Micro Electronics Technology,	
	1.2	Real world examples (Air-Bag, DMD, Pressure Sensors), MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications	
2		**MEMS Materials and Their Properties**	**8**
	2.1	Materials (eg. Si, SiO_2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt)	
	2.2	Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.	
3		**MEMS Sensors, Actuators and Structures**	**8**
	3.1	MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	
	3.2	Micro Actuation Techniques (Thermal, Piezo electric, Electro static, Shape Memory Alloys, **LORENTZ FORCE ACTUATION**), Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.	
4		**MEMS Fab Processes**	**10**
	4.1	MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio Micro	
	4.2	Machining (LIGA, Laser), X-Ray Lithography, Photolithography, PVD techniques, Wet, Dry, Plasma	
	4.3	etching, DRIE, Etch Stop Techniques. Die, Wire & Wafer Bonding, Dicing, Packaging(with Metal	
5		**MEMS Devices**	**12**
	5.1	Architecture, working and basic behaviour of Cantilevers, Micro heaters, Accelerometers, Pressure Sensor types, Micromirrors in DMD, Inkjet printer-head. Steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	**6**

	6.1	Piezo-resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior	
	6.2	MEMS Failure Mechanisms and Reliability.	
Total			**48**

Recommended Books:

1. MEMS and MICROSYSTEMS Design and Manufacture by Tai Ran Hsu : McGraw Hill Education
2. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
3. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
4. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
5. Micro-system Design - by S. Senturia; Publisher: Springer
6. Analysis and Design Principles of MEMS Devices - MinhangBao; Publisher: Elsevier Science
7. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2 edition
8. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4.Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8043	Virtual Instrumentation	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation	20	20	20	80	-	-	100

Rationale :- Virtual instrumentation combines mainstream commercial technologies such as the PC, with flexible software and a wide variety of measurement hardware, so one can create user-defined systems that meet their exact application needs. Virtual instrumentation has led to a simpler way of looking at measurement systems. Instead of using several stand-alone instruments for multiple measurement types and performing rudimentary analysis by hand, engineers now can quickly and cost-effectively create a system equipped with analysis software and a single measurement device that has the capabilities of a multitude of instruments for various applications & measurements.

Course Objectives :-

1. To understand virtual instrumentation (VI) & to realize its architecture

2. To familiarize with VI software & learn programming in VI

3. To study various instruments interfacing & data acquisition methods

4. To understand various analysis tools & develop programs for different measurement applications

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Explain the concepts of virtual instrumentation
- **CO-2 :-** Select the proper data acquisition hardware
- **CO-3 :-** Configure the data acquisition hardware using LabVIEW
- **CO-4 :-** Use LabVIEW to interface related hardware like transducers
- **CO-5 :-** Design virtual instruments for practical applications

Module No.	Topics	Hours
1	**INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)**	06
1.1	Historical perspective – Need for VI – Advantages of VI – Definition of VI – Block diagram & architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming	
2	**PROGRAMMING TECHNIQUES**	08
2.1	VI & sub-VI – Loops & charts – Arrays – Clusters – Graphs – Case & sequence structures – Formula nodes – Local & global variables – String & files inputs	
3	**APPLICATION DEVELOPMENT SOFTWARE (LabVIEW)**	10
3.1	Creating virtual instrument in LabVIEW – Implementing dataflow programming in LabVIEW – VI, sub-VI & modular code creation in LabVIEW – Arrays & file I/O in LabVIEW – Textual math integration in LabVIEW – Interfacing external instruments to PC using LabVIEW	
4	**DATA ACQUISITION BASICS**	08
4.1	Digital I/O – Counters & timers – PC hardware structure – Timing – Interrupts – DMA – Software & hardware installation – IEEE GPIB 488 concepts – Embedded system buses – PCI – EISA – CPCI	
5	**COMMON INSTRUMENT INTERFACES**	08
5.1	Current loop – RS 232C / RS 485 – Interface basics – USB – PCMCIA – VXI – SCXI – PXI – Networking basics for office & industrial application VISA & IVI – Image acquisition & process – Motion control – Digital multimeter (DMM) – Waveform generator	
6	**USING ANALYSIS TOOLS & APPLICATION OF VI**	08
6.1	Fourier transform – Power spectrum – Correlation method – Windowing & filtering – Pressure control system – Flow control system – Level control system – Temperature control system – Motion control employing stepper motor – PID controller toolbox	
1 – 6	**TOTAL**	48

Recommended Books :-

1. Dr. Sumathi S. & Surekha P, LabVIEW Based Advanced Instrumentation System, PHI, 2nd edition (2007)
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, 2nd edition (2006)
3. Lisa K. Wells & Jeffrey Travis, LabVIEW for Everyone, PHI, 3rd edition (2009)

4. Robert H. Bishop, Learning with LabVIEW 7 Express, Pearson Education, 1st edition (2005)
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2nd edition (2010)

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8044	Digital Image Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO 8044	Digital Image Processing	20	20	20	80	-	-	100

Course Pre-requisite:

- Applied Mathematics
- Signals and Systems

Course Objectives:

1. To learn the fundamental concepts of Digital Image Processing through basic spatial and frequency domain techniques.

2. To learn Image Compression and Decompression Techniques and compression standards.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of Digital Image representation and simple pixel relations.

2. Explain spatial domain and frequency domain techniques for digital image enhancement.
3. Perform segmentation and morphological operations.
4. Apply compression and decompression techniques to different digital images.

Module No.	Unit No.	Topics	Hrs.
1		**Digital Image Processing Fundamentals**	04
	1.1	**Introduction:** Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	**Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image	
		Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels,	
		Image File Formats : BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	
2		**Image Enhancement in Spatial Domain**	08
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations,	
		Histogram Processing, Image Subtraction, Image Averaging,	
		Spatial domain filters: Smoothing Filters, Sharpening Filters,High boost filter	
3		**Image Segmentation and Representation**	08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding,	
		Region based Segmentation, Split and Merge Technique	
	3.2	Image Representation and Description, Chain Code, Polygonal Representation,	
		Shape Number, Two Dimensional Moments.	
4		**Binary Image Processing**	06
	4.1	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction,	
		Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling	
5		**Image Transforms and frequency domain processing**	12
	5.1	Introduction to 2 Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform(FFT), Computation of 2 DFFT	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete	

		Cosine Transform(DCT), Introduction to Discrete Wavelet Transform (DWT)	
	5.3	Enhancement in the frequency domain: Frequency Domain Filtering Lowpass Filtering, Highpass Filtering, Homomorphic Filtering, Generation of Spatial Masks from Frequency Domain Specifications	
6		**Image Compression:**	10
	6.1	Fundamentals :Coding Redundancy, Interpixel Redundancy, Psycho visual	
		Redundancy	
	6.2	Image Compression Models :The Source Encoder and Decoder, Lossless	
		Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman	
		Coding, Differential PCM,	
	6.3	Lossy Compression Techniques: Predictive Coding, Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1. , Fidelity Criteria.	
Total			**48**

Text Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Second Edition, Thomson Learning, 2001
3. William K. Pratt, "Digital Image Processing", Third Edition, John Wiley & Sons, Inc., 2001

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

e Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	8

	GANTT chart. Introduction to Project Management Information System (PMIS).	
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO8022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;	09

	Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	**Enterprenership Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,	08

	Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-	7

	making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	10

	Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm’s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship	08

	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**

03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	07

	of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books

9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 801	Internet of Things Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 801	Internet of Things Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:
(Programming using C, Embedded C, Pyhton is to be encouraged)

1. Minimum two Experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for data handling and storage.
2. Minimum three experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for interfacing various sensors and communicating data using Internet using various Protocols.
3. Minimum two experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) and wireless communication protocol (802.11 and 802.14.5 IEEE standard)
4. Minimum one experiment using Cloud Storage.

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 802	Analog and Mixed VLSI Design	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 802	Analog and Mixed VLSI Design	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

Use of Online Tools to study analog VLSI circuits

2. Analysis of MOSFETs for analog performance
3. Design and simulate various types of current mirror circuits
4. Design and simulate various common source amplifier circuits
5. Design and simulate various types of single stage amplifiers
6. Design and simulate differential amplifier
7. Design and simulate operational tran-sconductance amplifier
8. Design and simulate switch capacitor circuits
9. Design and simulate various types of oscillators
10. Design and simulate mixed mode circuit
11. Generate layout for the simple and cascode current mirror
12. Generate layout for common source amplifier
13. Generate layout for the differential amplifier

14. Generate layout for the Oscillator

15. Generate layout for Phase Detector

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit proper report covering the latest advances in the field of Mixed VLSI Design.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8041	Advanced Power Electronics Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8041	Advanced Power Electronics Lab.	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

1. Single Phase Full Controlled Bridge Rectifier.
2. Speed control of Separately excited DC motor using Armature Voltage Control
3. Speed control of 3-phase Induction Motor using V/F control.
4. Simulation of 3-phase fully controlled Bridge rectifier with R and RL load.
5. Simulation of 1-phase fully controlled Bridge rectifier and study of various parameters.
6. Simulation of 1-phase Inverter and study of various Performance parameters.
7. Simulation of SVM Inverter.
8. Simulation of Closed loop dc-dc converter
9. Study High Frequency Induction heating & Dielectric heating.
10. Study of operation and control of solid state relays.

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8042	MEMS Technology Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8042	MEMS Technology Lab.	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

1. Design electro-statically actuated cantilever
2. Design bimorph cantilever which act as pressure sensor.
3. Dynamic analysis of Beam
4. Find the tip deflection of the cantilever with different types of load
5. Find the tip deflection of the cantilever in sweep analysis
6. Model and simulate Electro-mechanical actuator. Do dc and transient analysis
7. Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature
8. Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam
9. Model and simulate of accelerometer
10. Case study of MEMS based device

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8043	Virtual Instrumentation Laboratory	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation Laboratory	--	--	--	--	25	25	50

Term Work :-

At least 6 experiments covering entire syllabus of ELXDLO8043 (Virtual Instrumentation) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Virtual Instrumentation need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested List of Experiments :-

1. Verification of arithmetic operations
2. Verification of Boolean Expressions / half-adder & full-adder
3. Implementation of array functions
4. Program to convert Celsius into Fahrenheit & vice-versa
5. Program for implementing seven segment display
6. Program for calculating body mass index (BMI) using cluster

7. Program to control temperature using thermistor / RTD & DAQ
8. Program to control liquid flow using DAQ
9. Program to control liquid level using DAQ
10. Program to control pressure using DAQ
11. Program for DC motor speed control using PID toolbox

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8044	Digital Image Processing	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8044	Digital Image Processing	--	--	--	--	25	25	50

Term Work :-

At least 7 experiments covering entire syllabus of ELXDLO8044 (Digital Image Processing) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Digital Image Processing need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL704 ELXL803	Project I Project II	-	06 12	--	-	03 06	--	09

Objectives:

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research Outcomes

Outcome:

Learner will be able to:

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution is to be validated with proper justification and the report needs to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization
d) Clarity of objective and scope
e) Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization / Industrial trends
d) Clarity of objective and scope
e) Quality of work attempted
f) Validation of results
g) Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.
Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai Students should be motivated to publish a paper in Conferences/students competitions based on the work

Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 ‘C’ Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Item No. 145

AC – 23/07/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date 02-07-2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
ECC302	Electronic Devices & Circuits	3	--	--	3	--	--	3
ECC303	Digital System Design	3	--	--	3	--	--	3
ECC304	Network Theory	3	--	1	3	--	1	4
ECC305	Electronic Instrumentation & Control Systems	3	--	--	3	--	--	3
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1
ECL302	Digital System Design Lab	--	2	--	--	1	--	1
ECL303	Electronic Instrumentation & Control Systems Lab	--	2	--	--	1	--	1
ECL304	Skill Lab: C++ and Java Programming	--	4	--	--	2	--	2
ECM301	Mini Project 1A	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

*** Should be conducted batch wise.**

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ECC302	Electronic Devices & Circuits	20	20	20	80	3	--	--	100
ECC303	Digital System Design	20	20	20	80	3	--	--	100
ECC304	Network Theory	20	20	20	80	3	25	--	125
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	3	--	--	100
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	--	25	25	50
ECL302	Digital System Design Lab	--	--	--	--	--	25	--	25
ECL303	Electronic Instrumentation & Control Systems Lab	--	--	--	--	--	25	--	25
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	--	25	25	50
ECM301	Mini Project 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**175**	**75**	**750**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
ECC402	Microcontrollers	3	--	--	3	--	--	3
ECC403	Linear Integrated Circuits	3	--	--	3	--	--	3
ECC404	Signals & Systems	3	--	1	3	--	1	4
ECC405	Principles of Communication Engineering	3	--	--	3	--	--	3
ECL401	Microcontrollers Lab	--	2	--	--	1	--	1
ECL402	Linear Integrated Circuits Lab	--	2	--	--	1	--	1
ECL403	Principles of Communication Engineering Lab	--	2	--	--	1	--	1
ECL404	Skill Lab: Python Programming	--	4	--	--	2	--	2
ECM401	Mini Project 1B	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**7**	**2**	**24**

*** Should be conducted batch wise.**

$ Indicates work load of a learner (Not Faculty) for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ECC402	Microcontrollers	20	20	20	80	3	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ECC404	Signals & Systems	20	20	20	80	3	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	3	--	--	100
ECL401	Microcontrollers Lab	--	--	--	--	--	25	--	25
ECL402	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50
ECL404	Skill Lab: Python Programming	--	--	--	--	--	25	25	50
ECM401	Mini Project 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**175**	**100**	**775**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC301	Engineering Mathematics-III	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Duration (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications.
2. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.
3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra.
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: After successful completion of course student will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5. Use matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $sin(at), cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	7
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7
05	**Module: Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Module: Vector Differentiation and Integral** 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector	6

	fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	
	Total	39

References:

1. Advanced engineering mathematics, H.K. Das, S . Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment Test (20-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Subject Code	**Subject Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ECC302	Electronic Devices & Circuits	3	-	--	3	--	--	3

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory Marks				**Exam Duration (in Hrs.)**	**Term Work**	**Practical & Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Avg. of Test 1 and Test 2**					
ECC302	Electronic Devices & Circuits	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC: 102 - Engineering Physics-I
FEC: 201 - Engineering Physics-II
FEC:105 - Basic Electrical Engineering

Course Objectives:

1. To explain functionality different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers.
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and it's applications in Operational Amplifiers

Course Outcomes:

After successful completion of the course student will be able to:

1. Know functionality and applications of various electronic devices.
2. Explain working of various electronics devices with the help of V-I characteristics.
3. Derive expressions for performance parameters of BJT and MOSFET circuits.
4. Evaluate performance of Electronic circuits (BJT and MOSFET based).
5. Select appropriate circuit for given application.
6. Design electronic circuit (BJT, MOSFET based) circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Electronic Devices**	**05**
	1.1	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator.	
	1.2	Construction, working and characteristics of BJT, JFET, and E-MOSFET	
2.0		**Biasing Circuits of BJTs and MOSFETs**	**06**
	2.1	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias)	
	2.2	DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for JFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	
3.0		**Small Signal Amplifiers**	**06**
	3.1	Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifier using hybrid pi model.	
	3.2	Small signal analysis (Zi, Zo, Av) of CS (for EMOSFET) amplifiers.	
	3.3	Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	
4.0		**Frequency response of Small signal Amplifiers:**	**08**
	4.1	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance.	
	4.2	High and low frequency analysis of CE amplifier.	
	4.3	High and low frequency analysis of CS (E-MOSFET) amplifier.	
5.0		**Large Signal Amplifiers:**	**06**
	5.1	Difference between small signal & large signal amplifiers. Classification and working of Power amplifier	
	5.2	Analysis of Class A power amplifier (Series fed and transformer coupled).	
	5.3	Transformer less Amplifier: Class B power amplifier. Class AB output stage with diode biasing	
	5.4	Thermal considerations and heat sinks.	
6.0		**Introduction to Differential Amplifiers**	**08**
	6.1	E-MOSFET Differential Amplifier, DC transfer characteristics, operation with common mode signal and differential mode signal	
	6.2	Differential and common mode gain, CMRR, differential and common mode Input impedance.	
	6.3	Two transistor (E-MOSFET) constant current source	
		Total	**39**

Text books:

1. D. A. Neamen, “Electronic Circuit Analysis and Design,” Tata McGraw Hill, 2ndEdition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, “Microelectronic Circuits Theory and Applications,” International Version, OXFORD International Students, 6thEdition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

References:

1. Boylestad and Nashelesky, “Electronic Devices and Circuits Theory,” Pearson Education, 11th Edition.
2. A. K. Maini, “Electronic Devices and Circuits,” Wiley.
3. T. L. Floyd, “Electronic Devices,”Prentice Hall, 9th Edition, 2012.
4. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

NPTEL/ Swayam Course:

1. Course: Analog Electronic Circuit By Prof. Shouribrata chatterjee (IIT Delhi); https://swayam.gov.in/nd1_noc20_ee89/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC303	Digital System Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC105 – Basic Electrical Engineering

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
3. To analyze, design and implement logical operations using various sequential logic circuits.
4. To study the characteristics of memory and their classification.
5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand types of digital logic, digital circuits and logic families.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design and implement sequential logic circuits.
4. Develop a digital logic and apply it to solve real life problems.
5. Classify different types of memories and PLDs.
6. Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Module No.	Unit No.	Topics	Hrs.
1.0		**Number Systems and Codes**	**04**
	1.1	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	04
2.0		**Logic Family and Logic Gates**	**05**
	2.1	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	03
	2.2	Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem	02
3.0		**Combinational Logic Circuits**	**12**
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	04
	3.2	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator	04
	3.3	Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder	04
4.0		**Sequential Logic Circuits**	**12**
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register	04
	4.2	Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter	04
	4.3	Applications of Sequential Circuits: Frequency division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits	04
5.0		**Different Types of Memories and Programmable Logic Devices**	**04**
	5.1	Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	02
	5.2	Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	02
6.0		**Introduction to VHDL**	**02**
	6.1	Basics of VHDL/Verilog Programming, Design and implementation of adder, subtractor, multiplexer and flip flop using VHDL/Verilog	02
		Total	**39**

Text Books:

1. John F. Warkerly, “Digital Design Principles and Practices”, Pearson Education, Fifth Edition (2018).
2. Morris Mano, Michael D. Ciletti, “Digital Design”, Pearson Education, Fifth Edition (2013).
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill Education, Forth Edition (2010).
4. A. Anand Kumar, “Fundamentals of Digital Circuits”, PHI, Fourth Edition (2016).
5. Volnei A. Pedroni, “Digital Electronics and Design with VHDL” Morgan Kaufmann Publisher, First Edition (2008).
6. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, Third Edition, MGH (2014).

Reference Books:

1. Thomas L. Floyd, “Digital Fundamentals”, Pearson Prentice Hall, Eleventh Global Edition (2015).
2. Mandal, “Digital Electronics Principles and Applications”, McGraw Hill Education, First Edition (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “Digital Systems Principles and Applications”, Ninth Edition, PHI (2009).
4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, “Digital Principles and Applications”, The McGraw Hill, Eight Edition (2015).
5. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic Design with VHDL”, Second Edition, TMH (2009).
6. J. Bhasker, “A Verilog HDL Primer”, Star Galaxy Press, Third Edition (1997).

NPTEL / Swayam Course:

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Network Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of Test 1 and Test 2					
ECC304	Network Theory	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. FEC105 - Basic Electrical Engineering
2. FEC201 - Engineerring Mathematics II

Course Objectives:

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Evaluate circuit using graph theory.
4. Find the various parameters of two port network.
5. Apply network topology for analyzing the circuit.
6. Synthesize the network using passive elements.

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrical circuit analysis**	08
	1.1	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using mesh analysis (for Two Loops only).	
2.0		**Graph Theory**	06
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	
3.0		**Time and frequency domain analysis**	07
3.0	3.1	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals.	
	3.2	Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	
4.0		**Network functions**	06
	4.1	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by graphical methods, testing for Hurwitz polynomial.	
	4.2	Analysis of ladder & symmetrical lattice network (Up to two nodes or loops)	
5.0		**Two port Networks**	05
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	
	5.2	Interconnections of Two-Port networks T & π representation.	
6.0		**Synthesis of RLC circuits**	07
	6.1	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions.	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms (Up to Two Loops only).	
		Total	**39**

Textbooks:

1. Franklin F Kuo, “Network Analysis and Synthesis”, Wiley Toppan, 2nd ed. ,1966.
2. M E Van Valkenburg, “Network Analysis”, Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

Reference Books:

1. A. Chakrabarti*, “Circuit Theory”,* Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli “Circuits and Networks”, Tata McGraw-Hill education.
3. Smarajit Ghosh “Network Theory Analysis & Synthesis”, PHI learning.
4. K.S. Suresh Kumar, “Electric Circuit Analysis” Pearson, 2013.
5. D. Roy Choudhury, “Networks and Systems” , New Age International, 1998.

NPTEL / Swayam Course:

1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras); https://swayam.gov.in/nd1_noc20_ee64/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least **10 assignments** covering entire syllabus must be given during the **“Class Wise Tutorial”**. The assignments should be students’ centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	03	--	--	100

Course pre-requisites:

1. FEC105 – Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and transducers
2. To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcomes:

After successful completion of the course student will be able to:

1. Identify various sensors, transducers and their brief performance specification.
2. Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry
3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems.
4. Obtain the transfer functions for a given Control system.
5. Understand the analysis of systems in time domain and frequency domain.
6. Predict stability of given system using appropriate criteria.

Module No.	Unit No.	Topics	Hrs.
1		**Principle of Measurement, Testing and Measuring instruments**	04
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge	
2		**Sensors and Transducers**	06
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers (LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors (RTD). Thermistors and thermocouples, their ranges and applications	
3		**Introduction to control system Analysis**	08
	3.1	Introduction: Open and closed loop systems, example of control systems	
	3.2	Modelling: Modelling, Transfer function model	
	3.3	Block diagram reduction techniques and Signal flow graph	
4		**Response of control system**	04
	4.1	Dynamic Response: Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
	4.2	Concept of lag and lead compensator.	
5		**Stability Analysis in Time Domain**	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system	
6		**Stability Analysis in frequency domain**	09
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin	
Total			39

Textbooks:

1. A.K. Sawhney, “*Electrical & Electronic Measurement & Instrumentation”* – DRS .India
2. B.C Nakra, K.K. Cahudhary, Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
3. W.D. Cooper, “*Electronic Instrumentation And Measuring Techniques”* –PHI
4. Nagrath, M.Gopal, “*Control System Engineering*”, Tata McGrawHill.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed.,2004.
6. K.Ogata, “*Modern Control Engineering*, Pearson Education”, IIIrd edition.

Reference Books:

1. Helfrick&Copper, “*Modern Electronic Instrumentation & Measuring Techniques”* –PHI
2. M.M.S. Anand, “*Electronic Instruments and instrumentationTechnology”*.
3. Gopal M., “Control Systems Principles and Design”, Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
4. Benjamin C.Kuo, “*Automatic Control Systems*, Eearson education”, VIIthedition
5. Doeblin E.D., Measurement system, Tata Mc Graw Hill., 4th ed, 2003.Madan Gopal, “Control Systems *Principles and Design”*, Tata McGraw hill, 7th edition,1997.
6. Normon, “*Control System Engineering”*, John Wiley & sons, 3rdedition.

NPTEL/ Swayam Course:

1. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras);
https://swayam.gov.in/nd1_noc20_ee90/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	**Subject Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical/ Oral**	**Tutorial**	**Total**
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1

Subject Code	**Subject Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical and Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test 1	**Test 2**	**Avg. Of Test 1 and Test 2**				
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with equipments and measuring instruments used to perform Electronics Devices and Circuits laboratory work.
2. To provide hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.
3. To develop an ability among students to gather appropriate data and analyse the same to relate theory with practical.
4. To develop trouble shooting abilities among students.

Course Outcomes:

After successful completion of the course students will be able to:

1. Know various equipments, electronics devices and components, and measuring instruments used to perform laboratory work.
2. Students will be able to explain functionality of various equipments, electronics devices and components and neasu6 instruments used to perform laboratory work.
3. Students will be able connect various equipments, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4. Students will able to perform experiment to gather appropriate data.
5. Students will able to analyze data obtained from experiment to relate theory with experiment results.
6. Students will able to prepare laboratory report (Journal) to summarise the outcome each experiment.

Laboratory plan:

Maximum of 10 practicals including minimum 2 to 3 simulations should be conducted.
Suggested list of experiments:

1. To study of pn junction diode characteristics.
2. To study zener as a voltage regulator.
3. To study characteristics of CE configuration.
4. To study BJT biasing circuits.
5. To study BJT as CE amplifier.
6. To study frequency response of CE amplifier.
7. To study EMOSFET biasing circuits.
8. Simulation experiment on study of CS amplifier.
9. Simulation experiment on study frequency response of CS amplifier.
10. Simulation experiment on study of differential amplifier.
11. Simulation experiment on multistage amplifier.

Term Work: At least 10 Experiments including not more than 03 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL302	Digital System Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL302	Digital System Design Lab	--	--	--	--	25	--	25

Course objectives:

1. To get familiarise with basic building blocks of Digital System Design and verify the operation of various digital ICs.
2. To train students to design and implementation of combinational circuits.
3. To instruct students on how to design and implement sequential circuits.
4. To introduce simulation software like VHDL/Verilog to design basic digital circuits.

Course outcomes:

Learners will be able to …

1. Identify various Digital ICs and basic building blocks of digital system design
2. Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3. Identify and understand working of various types of flip flops and their inter conversions.
4. Design and implement basic sequential circuits such as counters, registers etc.
5. Acquire basic knowledge of VHDL/Verilog basic programming.

Suggested list of experiments:

1. Simplification of Boolean functions.
2. Design AND, OR, NOT, EXOR, EXNOR gates using Universal gates: NAND and NOR.
3. Implement digital circuits to perform Binary to Gray and Gray to Binary operations.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Design and implement BCD adder using 4-bit Binary Adder IC-7483.
6. Implement logic equations using Multiplexer.
7. Verify encoder and decoder operations.

8. Design and implement Magnitude Comparator.
9. Verify truth table of different types of flip flops.
10. Flip flop conversions JK to D, JK to T and D to TFF.
11. Design asynchronous/synchronous MOD N counter using IC7490.
12. Verify different counter operations.
13. Write VHDL/Verilog simulation code for different logic gates.
14. Write VHDL/Verilog simulation code for combinational and sequential circuits.
15. Write VHDL/Verilog simulation code for 4:1 Multiplexer, 2 to 4 line binary decoder.

Term Work:

At least 08 experiments covering the entire syllabus must be given "**Batch Wise"**. Out of these, **06 hardware experiments**, to be done strictly on breadboard and **at least 02 software experiments** using VHDL/Verilog. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	**Subject Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Pract.**	**Tut.**	**Total**
ECL303	Electronic Instrumentation & Control Systems Lab.	--	2	--	--	1	--	1

Subject Code	**Subject Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical & Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
ECL303	Electronic Instrumentation & Control Systems Lab.	--	--	--	--	25	--	25

Course Objectives:

1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance.
2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement.
3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems.
4. To examine steady-state and frequency response of first and second order electrical systems.
5. To inspect stability analysis of system using Root locus, Bode plot, polar plot and Nyquist plot.

Course Outcomes:

After successful completion of the course student will be able to:

1. Plot and validate the performance characteristics of transducers.
2. Validate the characteristics of various temperature, pressure and level transducers.
3. Plot frequency response of first-order electrical system.
4. Plot time response of second-order electrical system and calculate the steady-state error.
5. Validate the effect of damping factor on the response of second order system.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

List of experiments:

1. Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
2. Designing AC bridge Circuit for capacitance measurement.
3. Study and characteristics of Resistive Temperature Detector (RTD).
4. Study of Linear Variable Differential Transformer (LVDT)
5. To plot the effect of time constant on first-order systems response.
6. To plot the frequency response of first-order System
7. To plot the time response of second-order systems
8. To plot the frequency response of second-order System
9. To Examine Steady State Error for Type 0, 1, 2 System
10. To study the performance of Lead and Lag Compensator
11. To inspect the relative stability of systems by Root-Locus using Simulation Software.
12. To determine the frequency specification from Polar plot of system
13. To inspect the stability of system by Nyquist plot using Simulation software.
14. To inspect the stability of system by Bode plot using Simulation software.
15. Any other experiment based on syllabus which will help students to understand topic/concept.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL304	Skill Lab: C++ and Java Programming	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	25	25	50

Note: Before performing practical **'Necessary Theory'** will be taught by concern faculty

Course Pre-requisites:

1. FEL204 - C-Programming

Course Objectives:

1. Describe the principles of Object Oriented Programming (OOP).
2. To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3. Utilize the object-oriented paradigm in program design.
4. To lay a foundation for advanced programming.
5. Develop programming insight using OOP constructs.

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe the basic principles of OOP.
2. Design and apply OOP principles for effective programming.
3. Develop programming applications using OOP language.
4. Implement different programming applications using packaging.
5. Analyze the strength of OOP.
6. Percept the Utility and applicability of OOP.

Module No.	Unit No.	Topics	Hrs.
1.0		**C++ Overview**	08
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object oriented programming language.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2.0		**C++ Control Structures**	08
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.	
3.0		**Object-Oriented Programming using C++**	12
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4.0		**Introduction to Java**	06
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5.0		**Inheritance, Polymorphism, Encapsulation using Java**	10

	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	
	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6.0		**Exception Handling and Applets in Java**	**08**
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**52**

Suggested list of Experiments:

Note: *Before performing practical necessary Theory will be taught by concern faculty*

Sr.No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Textbooks:

1. Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education.
2. Yashwant Kanitkar, “Let Us Java”, 2nd Edition, BPB Publications.
3. D.T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition: 2015
4. Deitel, “C++ How to Program”, 4th Edition, Pearson Education.

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010.

Skill-Enhancement:

1. The students should be trained to code in Eclipse (an industry accepted software tool). Also, for a given problem statement, there is need to include external library files (other than JDK files). Moreover, the students need to be trained on Maven (a build tool).
2. Real-life mini-problem statements from software companies (coming in for placement) to be delegated to groups of 3-4 students each and each group to work on the solution for 8-12 hours (last 2 lab sessions).

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Term Work:

At least **12** experiments (**06 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.
The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam should cover all **12** experiments for examination.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A	--	04$	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual’s as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1A, in case it is half-year project.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	04$^{\$}$	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Pre-requisite:

1. FEC105 - BEE

Course Objectives:

1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems
2. To familiarize the students with the designing and making of Printed circuit boards(PCB)
3. To improve the knowledge of electronics hardware among students

Course outcomes:

After successful completion of the course student will be able to:

1. Create the electronics circuit for particular application/experiment.
2. Design and simulate the circuits by putting together the analog and digital components
3. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
4. Realize the PCB design process and gain up-to-date knowledge of PCB design software.
5. Utilize the basic electronic tools and equipment's (like DMM, CRO, DSO etc.)
6. Analysis of hardware fault (Fault detection and correction)

Module No.	Unit No.	Topics	Hrs.
1.0		**Identification and Designing of Circuit**	**08**
	1.1	Identification of particular application with understanding of its detail operation. Study of necessary components and devices required to implement the application.	
	1.2	Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc)	
2.0		**Software simulation and Implementation on GPP**	**12**
	2.1	Simulation of circuit for particular application using software's to verify the expected results	
	2.2	Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
3.0		**PCB design and optimization**	**08**
	3.1	Design the circuit by placing components using PCB design software's.	
	3.2	Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material	
4.0		**Implementation of PCB**	**08**
	4.1	Transfer the designed PCB on Copper clad either by using dark room or taking printout on glossy paper, etc (use available suitable method).	
	4.2	Perform Etching and then Soldering.	
5.0		**Detection of Hardware faults and Result verification**	**08**
	5.1	Identify the hardware faults in designed circuit and subsequently rectify it	
	5.2	Now again verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
6.0		**Understanding the Troubleshooting**	**08**
	6.1	Understand the trouble shooting by removing some wired connection.	
	6.2	Understand the trouble shooting of track. Troubleshoot the faculty components or devices	
		Total	**52**

NOTE: During 1st week or within 1-month of the beginning of the semester, following topics related to ADC and DAC should be covered as theoretical concepts.

a. **Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.**

b. **Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.**

Reference books:

1. Schultz Mitchel E., *"Grob's Basic Electronics",* McGraw-Hill Education; 10th edition, 25 October , 2006.
2. Charles Platt, *"Make Electronics: Learning by discovery",* O'Reilly; 2nd edition, 18 September , 2015.
3. Forrest M Mims III, *"Getting started in Electronics",* Book Renter, Inc.; 3rd edition , 1 January 2000.

4. R S Khandpur, "*Printed circuit board*", McGraw-Hill Education; 1st edition, 24 February , 2005.
5. Kraig Mitzner, "*Complete PCB Design Using OrCAD Capture and PCB Editor",* Academic Press; 2nd edition , 20 June 2019.

Suggested Software tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html#
2. Eagle : https://www.autodesk.in/products/eagle/overview
3. OrCAD: https://www.orcad.com/
4. Multisim : https://www.multisim.com/
5. Webbench:http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html
6. Tinkercad : https://www.tinkercad.com/

Online Repository:

1. https://www.electronicsforu.com
2. https://circuitdigest.com
3. https://www.electronicshub.org

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC401	Engineering Mathematics-IV	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Duration (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg. of Test 1 & 2					
ECC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. ECC301-Engineering Mathematics-III & Binomial Distribution.

Course Objectives: The course is aimed:

1. To understand line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To understand probability distributions and expectations.
4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To understand the concepts of Quadratic forms and Singular value decomposition.
6. To understand the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module	Detailed Contents	Hrs.
01	**Module: Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations ,Z- Transform.	7
02	**Module: Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Module: Probability Distributions** 1.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Module: Linear Algebra: Vector Spaces:-** 4.1 Vectors in n-dimensional vector space, norm, dot product, The CauchySchwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence and Independence, QR decomposition.	6
05	**Module: Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7

06	**Module: Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-** Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action , Several dependent variables.	6
Total		39

References:

1.Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2.Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5 Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
8.Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work (25-Marks):

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment Test (25-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Micro-controllers	3	-	--	3	-	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC402	Micro-controllers	20	20	20	80	03	-	-	100

Course Pre-requisites:

1. ECC303 - Digital System Design

Course objectives:

1. To develop background knowledge of Computer and its memory System.
2. To understand architecture of 8051 and ARM7 core.
3. To write programs for 8051 microcontrollers.
4. To understand design of Microcontroller Applications.

Course outcomes:

After successful completion of the course student will be able to:

1. Understand Computer and its memory System,
2. Understand the detailed architecture of 8051 and ARM7 Core.
3. Write programs for 8051 microcontrollers.
4. Design an applications using microcontroller.

Module No.	Unit No.	Topics	Hrs
1		**Overview of Microprocessor based System**	5
	1.1	Overview of microcomputer systems and their building blocks, Memory Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory	
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access	
	1.3	Concept of RISC & CISC Architecture	
	1.4	Harvard & Von Neumann Architecture	
2		**The Memory Systems**	4
	2.1	Classification of Memory : Primary and Secondary	
	2.2	Types of Semiconductor memories	
	2.3	Cache Memory	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)	
3		**8051 Microcontroller**	8
	3.1	Comparison between Microprocessor and Microcontroller	
	3.2	Features, architecture and pin configuration	
	3.3	CPU timing and machine cycle	
	3.4	Input / Output ports	
	3.5	Memory organization	
	3.6	Counters and timers	
	3.7	Interrupts	
	3.8	Serial data input and output	
4		**8051 Assembly Language Programming and Interfacing**	9
	4.1	Addressing modes	
	4.2	Instruction set	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts	
	4.5	Interfacing with LEDs, Relay and Keys	
5		**ARM7**	8
	5.1	Introduction & Features of ARM 7	
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M	
	5.3	Architectural inheritance, Pipelining	
	5.4	Programmer’s model	
	5.5	Brief introduction to exceptions and interrupts handling	
	5.6	Instruction set: Data processing, Data Transfer, Control flow	
6		**Study 8 bit microcontroller Applications**	5
	6.1	Understanding features of NXP 89v51RD2, Atmega 328P and PIC16F886	
	6.2	Selecting a microcontroller for an application	
	6.3	Study of 89v51 based Clock Using I2C RTC and Seven Segment Display	
	6.4	PIC16F886 Speed Control of DC Motor.	
	6.5	Atmega 328P based remote temperature monitoring with LCD display	
		Total	39

Text Books:

1. Douglas V Hall, SSSP Rao “Microprocessors & Interfacing”, McGraw Hill
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill
3. Shibu K. V “Introduction to embedded systems” McGraw Hill.
4. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, “The 8051 Microcontroller & Embedded systems”, Pearson Publications, Second Edition 2006.
5. C. Kenneth J. Ayala and D. V. Gadre, “The 8051 Microcontroller & Embedded system using assembly & ‘C’ ”, Cengage Learning, Edition 2010.
6. Steve Furber, “ARM System on chip Architecture”, Pearson,2nd edition.

Reference books:

1. “MCS@51 Microcontroller, Family User’s Manual” Intel
2. “PIC16F882/883/884/886/887 Data Sheet”, Microchip.
3. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
4. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips
5. James A. Langbridge, “Professional Embedded Arm Development”, Wrox, John Wiley Brand& Sons Inc., Edition 2014

NPTEL/ Swayam Course:

1. Course: Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur); **https://swayam.gov.in/nd1_noc20_ee42/preview**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	**Course Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ECC403	Linear Integrated Circuits	03	--	--	03	--	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Exam Duration (in Hrs)**	**Term Work**	**Prac. and Oral**	**Total**
		Internal assessment			**End Sem. Exam. (ESE)**				
		Test1	**Test2**	**Avg. of Test 1 and Test 2**					
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. ECC302-Electronic Devices & Circuits

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

After successful completion of the course student will be able to:

1. Outline and classify all types of integrated circuits.
2. Understand the fundamentals and areas of applications for the integrated circuits.
3. Develop the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical & practical results in integrated circuits.
5. Identify the appropriate integrated circuit modules for designing engineering application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Operational Amplifier**	**07**
	1.1	Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	
	1.2	Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.	
	1.3	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp.	
2.0		**Linear Applications of Operational Amplifier**	**08**
	2.1	Voltage to current and current to voltage converter.	
	2.2	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters.	
	2.3	Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3.0		**Non-Linear Applications of Operational Amplifier**	**07**
3.0	**3.1**	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector.	
4.0		**Timer IC 555 and it's applications**	**07**
	4.1	Functional block diagram and working of IC 555	
	4.2	Design of Astable and Monostable multivibrator using IC 555	
	4.3	Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator.	
5.0		**Voltage Regulators.**	**06**
	5.1	Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series).	
	5.2	Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC).	
	5.3	Introduction and block diagram of switching regulator, Introduction of LM 317.	
6.0		**Special Purpose Integrated Circuits**	**04**
	6.1	Functional block diagram and working of VCO IC 566 and application as frequency modulator.	
	6.2	Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	
		Total	**39**

Textbooks:

1. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.
2. D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.

Reference Books:

1. K. R. Botkar, “Integrated Circuits”, Khanna Publishers (2004)
2. Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, Tata McGraw Hill, 3rd Edition.
3. David A. Bell, “Operation Amplifiers and Linear Integrated Circuits”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “Operation Amplifiers and Linear Integrated Circuits”, Prentice Hall, 6th Edition.
5. J. Millman, Christos CHalkias, and Satyabratatajit, Millman’s,“Electronic Devices and Circuits,” McGrawHill, 3rdEdition.

NPTEL/ Swayam Course:

1. Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore);
https://swayam.gov.in/nd1_noc20_ee13/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ECC404	Signals and Systems	20	20	20	80	03	25	--	125

Course pre-requisite:

1. ECC301 – Engineering Mathematics III

Course objectives:

1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

Course outcomes:

After successful completion of the course student will be able to:

1. Classify and Analyze different types of signals and systems
2. Analyze continuous time LTI signals and systems in transform domain
3. Analyze and realize discrete time LTI signals and systems in transform domain
4. Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5. Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to signals and systems**	**07**
	1.1	**Introduction to Signals:** Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. **Classification of Signals:** analog and discrete time signals, even and odd signals, periodic and non-periodic signals , deterministic and non-deterministic signals, energy and power signals.	
	1.2	**Systems and Classification of systems:** System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.	
2.0		**Time domain analysis of Continuous Time and Discrete Time systems**	**07**
	2.1	**Linear Time Invariant (LTI) systems:** Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.	
	2.3	Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.	
3.0		**Fourier Analysis of Continuous and Discrete Time Signals and Systems**	**07**
	3.1	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform, Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	
4.0		**Laplace Transform and Continuous time LTI systems**	**06**
	4.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	
	4.2	**Analysis of continuous time LTI systems using Laplace Transform: C**ausality and stability of systems in *s*-domain, Total response of a system.	
5.0		***z*-Transform and Discrete time LTI systems**	**08**
	5.1	Need of *z*-Transform, *z*-Transform of finite and infinite duration sequences, Concept of Region of Convergence, *z*-Transform	

		properties, Standard *z*-transform pairs, relation between *z*-transform and discrete time Fourier Transform, one sided *z*-Transform. Inverse *z*-Transform: Partial Fraction method only.	
	5.2	**Analysis of discrete time LTI systems using *z*-Transform**: Systems characterized by Linear constant coefficient difference equation, Transfer Function, plotting Poles and Zeros of a transfer function , causality and stability of systems, Total response of a system.	
6.0		**FIR and IIR systems**	**04**
	6.1	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems.	
	6.2	**Realization structures of LTI system:** Direct form –I and direct form II, Linear Phase FIR structures.	
Total			**39**

Text books:

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Reference books:

1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
2) Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.
3) V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
5) Luis F. Chaparro, Signals and Systems Using MATLAB, Academic Press
6) Rangaraj M. Rangayyan, “Biomedical Signal Analysis- A Case Study Approach”, Wiley 2002.
7) Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

NPTEL/ Swayam Course:

1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview

Teachers and students are encouraged to use *Signals and Systems Laboratory: Virtual Laboratory* (Reference number 8) for demonstration of concepts such as systems and their properties, Fourier analysis etc.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 06 Tutorials covering entire syllabus and 01 course project must be given during the “Class Wise Tutorial”.

Students can form team of maximum 4 members and work on course project using any software viz. C, Python, Scilab, Matlab, Octave, etc. The course project should be appropriately selected in order to demonstrate any concept learnt in this course.

03-hours (out of the total 12-hours allotted for the tutorials) can be utilized for the course project completion.

Term work assessment must be based on the overall performance of the student with every tutorial and a course project graded from time to time. The grades will be converted to marks as per “Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Prac. & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC301 - Engineering Mathematics- III
2. ECC302 - Electronic Devices and Circuits

Course Objectives:

1. To illustrate the fundamentals of basic communication system.
2. To understand various analog modulation and demodulation techniques.
3. To focus on applications of analog modulation and demodulation techniques.
4. To explain the key concepts of analog and digital pulse modulation and demodulation techniques.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand the basic components and types of noises in communication system.
2. Analyze the concepts of amplitude modulation and demodulation.
3. Analyze the concepts of angle modulation and demodulation.
4. Compare the performance of AM and FM receivers.
5. Describe analog and digital pulse modulation techniques.
6. Illustrate the principles of multiplexing and demultiplexing techniques.

Module No.	Unit No.	Topics	Hours
1		**Basics of Communication System**	**05**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation.	**03**
	1.2	Types of noise, signal to noise ratio, noise figure, noise temperature and Friss formula.	**02**
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations.	**04**
	2.2	DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems.	**04**
	2.3	Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	**04**
3		**Angle Modulation and Demodulation**	**10**
	3.1	Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrowband FM and wideband FM.	**04**
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre- emphasis and de-emphasis	**03**
	3.3	FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, amplitude limiting and thresholding, Applications of FM and PM.	**03**
4		**Radio Receivers**	**04**
	4.1	Characteristics of radio receivers, TRF, Super - heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Communication receiver.	**03**
	4.2	FM receiver block diagram, comparison with AM receiver.	**01**
5		**Analog and Digital Pulse Modulation & Demodulation**	**06**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect.	**03**
	5.2	PAM, PWM, PPM generation, detection and applications. Basics of PCM system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM).	**03**
6		**Multiplexing & De-multiplexing**	**02**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications.	**02**
		Total	**39**

Textbooks:

1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital”, Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition.
4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011.
5. Louis Frenzel, “Communication Electronics”, Tata McGraw Hill, Third Edition.

NPTEL/ Swayam Course:

1. Course: Analog Communication By Prof. Goutam Das (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee69/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching Scheme (Hrs.)</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Total</th></tr>
<tr><td>ECL401</td><td>Micro-controllers Lab</td><td>-</td><td>2</td><td>-</td><td>-</td><td>1</td><td>-</td><td>1</td></tr>
</table>

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="5">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical And Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th><th rowspan="2">Exam. Duration (in Hrs)</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg. of Test 1 and Test 2</th></tr>
<tr><td>ECL401</td><td>Micro-controllers Lab</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>25</td><td>--</td><td>25</td></tr>
</table>

Course Objectives:

1. To understand development tools of microcontroller based systems.
2. To learn programming for different microcontroller operation & interface to I/O devices.
3. To develop microcontroller based applications.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand different development tools required to develop microcontroller based systems.
2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations.
3. Write assembly language programs for general purpose I/O, Timers & Interrupts.
4. Interface & write programs for Input and Output devices
5. Develop microcontroller based Applications.

Suggested Experiment List:

1. Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing)
2. Code Conversion
3. Transfer of data bytes between Internal and External Memory
4. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
5. Interfacing of Matrix Key board, LED, 7 Segment display, LCD, Stepper Motor, UART

At Least 10 experiment Minimum two from each category of above list must be given during the **Laboratory session batch wise**. Computation/simulation based experiments are also encouraged.

Before starting the experiments there should be one session on Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.

Mini project based on 8051 derivatives, PIC, AVR & other 8 bit microcontrollers using Assembly and/or C language. (Readymade of Arduino & raspberry pi are **not recommended here**)

Note: Mini Project can be considered as a part of term-work.

Term Work (25-Marks):

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	**Course Name**	**Teaching Scheme (Hrs.)**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ECL402	Linear Integrated Circuits Lab.	--	02	--	--	01	--	01

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Exam. Duration (in Hrs)**	**Term Work**	**Practical And Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Avg. Of Test 1 and Test 2**					
ECL402	Linear Integrated Circuits Lab.	--	--	--	--	--	25	25	50

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the differences between theoretical, practical and simulated results in integrated circuits.
2. Apply the knowledge to do simple mathematical operations.
3. Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.

Laboratory Plan:

Minimum 8 hardware practical (compulsorily based on IC 741, IC 555, IC 723 and remaining on VCO 566 or PLL 565) and 2 simulations should be conducted. At least one experiment from each Module of syllabus.

Suggested list of experiments:

1. Design inverting, non-inverting amplifier and buffer using IC 741.
2. Design summing and difference amplifier using op-amp.
3. Design voltage to current converter with grounded load.
4. Design and analyze Integrator
5. Design and analyze Differentiator
6. Design Schmitt trigger using Op-amp.
7. Design Wein bridge and RC phase shift Oscillator.
8. Design and analyze second order High pass and Low pass filter
9. Design and analyze Band pass and Band reject filter.
10. Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.
11. Design Monostable Multivibrator using IC 555.
12. Design Low voltage Low current voltage regulator using IC 723.
13. Design High voltage High current voltage regulator using IC 723.
14. Design Frequency Modulator using IC 566
15. Design FSK Demodulator using IC 565
16. Design Instrumentation amplifier using 3 Op-Amp.
17. Design Precision rectifier
18. Design Square & Triangular wave generator

Term Work (25-Marks):

At least 10 Experiments including 02 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Principles of Communication Engineering Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Lab.	--	--	--	--	--	25	25	50

Course Pre-requisites:

1. Usage of basic Electronic instruments and components.
2. Fundamentals of Electronic Devices and circuits

Course Objectives:

1. To give an understanding of Time and Frequency domain representation of signals.
2. To demonstrate continuous wave modulation and demodulation.
3. To demonstrate analog and digital pulse communication.
4. Able to use simulation software to build communication circuits.

Course Outcomes:

After successful performance of the practicals student will be able to:

1. Analyze analog modulation techniques.
2. Analyze the waveforms of Radio receivers.
3. Implement analog pulse modulation and demodulation circuits.
4. Demonstrate digital pulse modulation and demodulation techniques.
5. Verify the concepts of TDM and FDM.

Suggested list of Experiments:

Sr. No	Title
1	Generation of AM modulation and demodulation.
2	Analyze waveforms at various stages of SSB system.
3	Generation of FM modulation and demodulation.
4	Analyze the output waveforms of each block of AM transmitter /receiver
5	Analyze the output waveforms of each block of FM transmitter /receiver
6	Design and implement Pre-emphasis and De-emphasis circuit.
7	Verification of sampling theorem.
8	Generation of PAM modulation and demodulation.
9	Generation of PWM and PPM modulation and demodulation.
10	Demonstrate Digital pulse transmission technique (PCM)
11	Demonstrate Digital pulse transmission technique (DM,ADM)
12	Observation of TDM multiplexing and de-multiplexing signals.
13	Observation of FDM multiplexing and de-multiplexing signals.

Term Work (25-Marks):

At least **10** experiments (**07 hardware experiments and at least 03 software experiments**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and application oriented. Signal should be analyzed in time and frequency domain.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "**Credit and Grading System**" manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 10 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL404	Skill Lab: Python Programming	-	04	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL404	Skill Lab: Python Programming	-	-	-	-	25	25	50

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course pre-requisite:

1. ECL304 – Skill Lab: C++ and Java Programming.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Python**	6
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements	
2.0		**Functions and File I/O Handling**	8
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, *with* keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3.0		**Object Oriented Programming**	9
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4.0		**Graphical User Interface and Image processing**	9
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqlite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5.0		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6.0		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor,	
	6.5	Support Vector Machines	
		Total	**52**

Text Books:

1. Yashavant Kanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1 edition (8 July 2019).
2. Dusty Phillips, “Python 3 object-oriented Programming”, Second Edition PACKT Publisher August 2015.
3. John Grayson, “Python and Tkinter Programming”, Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python , E Balagurusamy, McGraw Hill Education.
7. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code”, Addison Wesley; 3 edition (1 October 2013).

Reference Books:

1. Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, “Head First Python” O′Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O′Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: https://www.python.org/downloads/
2. Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation : https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

The following list of experiments and course project is for illustration purpose. Faculty members are required to introduce their own innovative list of experiments based on above curriculum.

Sr. No.	Problem Statement	Module No.
1.	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures.	Module 1

	4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set s = {10, 2, -3, 4, 5, 88} a. Number of items in sets s b. Maximum element in sets s c. Minimum element in sets s d. Sum of all elements in sets s e. Obtain a new sorted set from s, set s remaining unchanged f. Report whether 100 is an element of sets s g. Report whether -3 is not an element of sets s.	
2.	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. Generate and print a list of tuples containing name, age and salary from the 3lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3.	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	Module 3
4.	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain individual histograms. 4.Write Python program for histogram equalization 5 Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5.	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a. Find and print the name of the country with the highest GDP b. Find and print the name of the country with the lowest GDP c. Print text and input values iteratively	Module 5

	d. Print the entire list of the countries with their GDPs e. Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a. a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6.	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server. 7. Write Python Program to study image morphological operations.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

1. Use of free cloud service such as Google Colab to run python scripts is encouraged.

2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Term Work (25-Marks):

At least **12 experiments and 01 course project** should be performed. Term work assessment must be based on the overall performance of the student with every experiment and project graded from time-to-time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini Project 1B	--	04$	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM401	Mini Project 1B	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1B, in case it is half-year project.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	04$	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	-	-	-	25	25	50

$ indicates work load of Learner (Not Faculty), for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course pre-requisite:

1. ECM301 – Mini-Project 1A
2. ECL304 – C++ and Java Programming
3. ECC302 – Electronic Devices and Circuit

Course Objectives:

1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board, Raspberry Pi, Arduino IDE (Integrated Development Environment) and Python programming.
2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board.
3. To increase students critical thinking ability and provide solutions to some real time problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources.
2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
3. Design Arduino based projects for a given problem.
4. Write code using python language using IDE for utilizing the onboard resources.
5. Apply the knowledge of interfacing different devices to raspberry Pi board to accomplish a given task.
6. Design Raspberry Pi based projects for a given problem.

Experiment No.	Unit No.	Section A: Arduino Board	Hrs.
EX.1.0		**Introduction to Arduino Board**	**02**
	1.1	**Introduction to Arduino Uno board and integrated development environment (IDE**	
	1	**Write the code for blinking the on board led with a specified delay** Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.	
EX.2.0		**GPIO (along with Analog pin) Programming**	**04**
	2.1	**Introduction to programming GPIO, Analog and PWM PINS.**	
	1	**Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.**	
	2	**Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.**	
	3.	**Generate varying duty cycle PWM using Arduino.**	
EX.3.0		**Controlling output devices/Displaying**	**04**
	3.1	**Introduction to different sensor (Analog and Digital), Relays, Motors and display.**	
	1	**Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.**	
	2	**Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device**	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.**	
5.0		**Sample Projects**	**10**
	1.	**Waste Management System**	
	2.	**Smart City Solutions**	
	3.	**Energy Monitoring Systems**	
	4.	**Smart Classrooms and learning Solutions**	
	5.	**Home security systems**	
	6.	**Smart Agriculture solutions**	
	7.	**Healthcare solutions.**	
	8.	**Industrial Applications**	
	9.	**IoT Applications**	
	10.	**Robotics**	
		Section 'A' Total Hrs.	**24**

Experiment No.	Unit No.	Section B: Raspberry Pi	Hrs.
EX.1.0		**Introduction to Raspberry PI**	**02**
	1.1	**What is Raspberry PI? Downloading and Installation of NOOBS, First Power-Up & Having a Look around, Introduction to the Shell and Staying updated.**	
	1	**Familiarization with Raspberry PI and perform necessary software installation.** Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	

EX.2.0		**Interfacing with Input / Output Devices using Python**	**04**
	2.1	**Introduction to Python, Connecting to the outside World with GPIO.**	
	1	**To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.	
	2	**To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).	
	3.	**To interface analog sensor using MCP 3008 analog to digital converter chip.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	
EX.3.0		**Interfacing Temperature Sensor, Motors, Display Devices.**	**04**
	3.1	**Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.**	
	1	**To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor.	
	2	**To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.	
	3	**To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing)** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.	
	2	**Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI**	
	3	**Write a program on Raspberry PI to upload temperature and humidity data from thingspeak cloud.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	
EX.5.0		**Understanding of Communication Protocols**	**04**
	5.1	**Introduction to MQTT, IFTTT protocols and configuration steps.**	
	1	**Write a program on Raspberry PI to publish temperature data to MQTT broker**	
	2	**Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.**	
	3	**Configuration of Webserver using Raspberry PI.**	
6.0		**Sample Projects**	**10**
	1.	**MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud**	
	2.	**License Plate Recognition using Raspberry Pi and OpenCV**	
	3.	**Real Time Face Recognition with Raspberry Pi and OpenCV**	
	4.	**Smart Garage Door Opener using Raspberry Pi**	

	5.	**Remote Controlled Car Using Raspberry Pi and Bluetooth**	
	6.	**Fingerprint Sensor based door locking system using Raspberry Pi**	
	7.	**Raspberry Pi Ball Tracking Robot using Processing**	
	8.	**Web Controlled Home Automation using Raspberry Pi**	
	9.	**Line Follower Robot using Raspberry Pi**	
	10.	**Raspberry Pi based Smart Phone Controlled Home Automation**	
	11.	**Web Controlled Raspberry Pi Surveillance Robotic Car**	
	12.	**Raspberry Pi Based Weight Sensing Automatic Gate**	
	13.	**Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector**	
	14.	**Detecting Colors using Raspberry Pi and Color Sensor TCS3200**	
	15.	**Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor**	
	16.	**Call and Text using Raspberry Pi and GSM Module**	
	17.	**Raspberry Pi Home Security System with Email Alert**	
	18.	**Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor**	
	19.	**Web Controlled Notice Board using Raspberry Pi**	
	20.	**RF Remote Controlled LEDs Using Raspberry Pi**	
	21.	**RFID and Raspberry Pi Based Attendance System**	
	22.	**Raspberry Pi Interactive Led-Mirror**	
	23.	**Garage Door monitor using Raspberry Pi**	
	24.	**Raspberry Pi Digital Code Lock on Breadboard**	
	25.	**Electronic Voting Machine using Raspberry Pi**	
		Section 'B' Total Hrs.	**28**
		Total A + B	**52**

Reference Books:

1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017)
2. Simon Monk, "Raspberry PI Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition
3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill
4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017)
5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)

Software Tools:

1. Raspbian OS: https://www.raspberrypi.org/downloads/
2. Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/
3. SD Card Formatter: https://www.sdcard.org/downloads/formatter/
4. Arduino IDE: https://www.arduino.cc/en/main/software

Online Repository:

1. GitHub
2. NPTEL Videos on Raspberry Pi and Arduino Programming
3. https://www.electronicsforu.com/raspberry-pi-projects
4. https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners
5. https://www.electronicshub.org/raspberry-pi-projects/

6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English
7. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: https://www.tinkercad.com/

AC 14/07/2016
Item No. 4.22

UNIVERSITY OF MUMBAI

Revised Syllabus for the

M.E.(Electronics Engineering)

Course: Electronics Engineering

As per Choice Based Credit and Grading System
with effective from the academic year 2016-17

From Co-ordinator’s Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO’s) give freedom to affiliated Institutes to add few (PEO’s) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner’s learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner’s performance. Credit grading based system was implemented for Master of Engineering from the academic year 2016-2017.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

Quality of education is one of the major factors to contribute to the growth of a nation and subsequently quality of education is largely decided by the syllabi of the Educational Programme and its proper implementation. In order to make M.E (Electronics) Engineering programme of University of Mumbai rich in quality, revision of the syllabi is being undertaken as per the guidelines of University of Mumbai. While deciding the core courses and department level optional courses, inputs from various stake holders were taken into account. The exposure to the latest technology and tools used all over the world is given by properly selecting courses and their hierarchy in the programme curriculum. Thus this syllabus is made to groom the postgraduate students to be made competent in all respect with best possible efforts put in by the experts in framing detailed contents of individual courses.

I, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, am happy to state here that, heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational Objectives as listed below as per National Board of Accreditation (NBA) guidelines.

1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner’s point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that small step taken in right direction will definitely help in providing quality education to the stake holders.

Finally, I express my sincere gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr. Sudhakar S Mande
Chairman BOS Electronics Engineering

Programme Structure for Master of Engineering– Electronics Engineering
(With effect from Academic Year 2016 – 2017)

SEMESTER – I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1011	Advanced Digital Communication	04	---	---	04	---	---	04
ELXC1012	Mixed Signal VLSI Design	04	---	---	04	---	---	04
ELXC1013	Power Electronics System Design	04	---	---	04	---	---	04
ELXDLO101X	Department Level Optional Course-I	04	---	---	04	---	---	04
ILO101X	Institute Level Optional Course -I	03	---	---	03	---	---	03
ELXL1011	Laboratory-I Advanced Digital Communication	---	02	---	---	01	---	01
ELXL1012	Laboratory-II Mixed Signal VLSI Design	---	02	---	---	01	---	01
TOTAL		19	04	---	19	02	---	21

Course Code	Course Name	EXAMINATION SCHEME – SEMESTER I							
		THEORY					MAXIMUM MARKS		
		INTERNAL ASSESSMENT (IA)			End Semester Examination (Marks)	Exam Duration (Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC1011	Advanced Digital Communication	20	20	20	80	03	---	---	100
ELXC1012	Mixed Signal VLSI Design	20	20	20	80	03	---	---	100
ELXC1013	Power Electronics System Design	20	20	20	80	03	---	---	100
ELXDLO101X	Department Level Optional Course-I	20	20	20	80	03	---	---	100
ILO101X	Institute Level Optional Course-I	20	20	20	80	03	---	---	100
ELEXL1011	Laboratory-I Advanced Digital Communication	---	---	---	---	---	25	25	50
ELEXL1012	Laboratory-II Mixed Signal VLSI Design	---	---	---	---	---	25	25	50
TOTAL		**100**	**100**	**100**	**400**	**---**	**50**	**50**	**600**

SEMESTER – II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2021	Digital Design with Reconfigurable Architecture	04	---	---	04	---	---	04
ELXC2022	Real Time System Design	04	---	---	04	---	---	04
ELXC2023	Advanced Signal Processing	04	---	---	04	---	---	04
ELXDLO202X	Department Level Optional Course II	04	---	---	04	---	---	04
ILO202X	Institute Level Optional Course-II	03	---	---	03	---	---	03
ELXL2021	Laboratory-III Digital Design with Reconfigurable Architecture	---	02	---	---	01	---	01
ELXL2022	Laboratory-IV Advanced Signal Processing (ASP)	---	02	---	---	01	---	01
TOTAL		19	04	---	19	02	---	21

Course Code	Course Name	EXAMINATION SCHEME – SEMESTER II							
		THEORY					MAXIMUM MARKS		
		INTERNAL ASSESSMENT (IA)			End Semester Examination (Marks)	Exam Duration (Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC2021	Digital Design with Reconfigurable Architecture	20	20	20	80	03	---	---	100
ELXC2022	Real Time System Design	20	20	20	80	03	---	---	100
ELXC2023	Advanced Signal Processing	20	20	20	80	03	---	---	100
ELXDLO202X	Department Level Optional Course-II	20	20	20	80	03	---	---	100
ILO202X	Institute Level Optional Course -II	20	20	20	80	03	---	---	100
ELXL2021	Laboratory-III Digital Design with Reconfigurable Architecture	---	---	---	---	---	25	25	50
ELXL2022	Laboratory-IV Advanced Signal Processing (ASP)	---	---	---	---	---	25	25	50
TOTAL		**100**	**100**	**100**	**400**	**---**	**50**	**50**	**600**

Course Code	**Department Level Optional Course-I (ELXDLO101X)**	**Course Code**	**Department Level Optional Course-II (EXCDLO202X)**
ELXDLO1011	Advanced Processor Architecture-I	ELXDLO2021	Advanced Processor Architecture-II
ELXDLO1012	Network & System Administration	ELXDLO2022	Wireless & Mobile Networking
ELXDLO1013	Microelectronics Devices	ELXDLO2023	Nanoelectronics
ELXDLO1014	Modeling & Simulations	ELXDLO2024	Mechatronics
ELXDLO1015	Advanced Digital Image Processing	ELXDLO2025	Virtual Instrumentation

Course Code	**Institute Level Optional Course-I (ILO101X)**	**Course Code**	**Institute Level Optional Course-II (ILO202X)**
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and CSR
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management

SEMESTER III

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXS3031	Seminar	---	06	---	---	03	---	03
ELXD3031	Dissertation-I	---	24	---	---	12	---	12
TOTAL		---	30	---	---	15	---	15

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXS3031	Seminar	---	---	---	---	50	---	50	100
ELXD3031	Dissertation-I	---	---	---	---	100	---	---	100
					TOTAL	150		50	200

SEMESTER IV

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXD4041	Dissertation-II	---	30	---	---	15	---	15
TOTAL		---	30	---	---	15	---	15

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXD4041	Dissertation-II	---	---	---	---	100	---	100	200
					TOTAL	100		100	200

Note:

- In case of Seminar (ELXS3031), 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I (ELXD3032) and Dissertation II (ETXD4041), 02 Hour / week / student should be considered for the calculation of load of a teacher

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1011	Advanced Digital Communication	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1011	Advanced Digital Communication	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Digital Communication

Course Objectives:-

1. To understand the concepts of random processes in communication systems.
2. To comprehend the error correcting codes and fundamental limits of their performance
3. To analyze different equalization techniques for channels with ISI and AWGN
4. To understand signal diversity and explore MIMO systems
5. To study multichannel and multicarrier systems

Course Outcomes:-

1. Ability to understand the nature of random processes and its statistical characteristics.
2. Ability to appreciate the importance of error correcting codes-Turbo and LDPC
3. Ability to analyze various equalizers and their use in communication systems.
4. Ability to identify the drawbacks of multipath systems and methods to overcome them.
5. Ability to understand and analyze multichannel and multicarrier systems.

Module No.	Unit No.	Topics	Hrs.
01		**Review of Random Processes**	**06**
	1.1	Definition of random process,	
	1.2	Specifying random process	
	1.3	Examples of discrete time and continuous time random processes	
	1.4	Stationary random process	
	1.5	Time Averages of random processes	
02		**Error Control Coding**	**12**
	2.1	Concept of Convolutional codes and its representation, transfer function, Convolutional Interleaving, Decoding of Convolutional codes (Viterbi decoding), and their performance in communication systems.	
	2.2	Turbo codes:-concepts, log-likelihood algebra, product code, Encoding with recursive systematic codes, Trellis decoding.	
	2.3	Low-density Parity-check codes:-construction, minimum distance of LDPC codes	
03		**Signaling over Band limited channel**	**08**
	3.1	Optimum receiver for channels with ISI and AWGN, Optimum maximum likelihood receiver, discrete time model for a channel with ISI.	
	3.2	Linear Equalization: Peak distortion criteria, mean square error criterion , Performance characteristics of MSE equalizer.	
	3.4	Decision feedback equalization: Co-efficient optimization, performance characteristics of Decision feedback equalizer, Iterative Equalization and Decoding- Turbo equalization	
04		**Adaptive Equalizer**	**06**
	4.1	Adaptive linear Equalizer:-Zero forcing algorithm, LMS algorithm, convergence properties of LMS algorithm.	
	4.2	Self recovering (Blind) equalization based on maximum likelihood criterion.	
05		**Signaling over fading channels**	**10**
	5.1	Channel model for Time variant multipath channels, classification of multipath channels, Signal design for fading multipath channels.	
	5.2	Performance Improvement through signal diversity, Rake receiver and multipath diversity, recombining techniques.	
	5.3	MIMO systems- Basic considerations, Channel Models for Multiple antenna system, signal transmission through slow fading frequency nonselective and frequency selective MIMO Channels.	
06		**Multichannel and Multicarrier system**	**10**
	6.1	Multiple access techniques: TDMA, FDMA, CDMA, Multichannel Digital Communication in AWGN Channels.	
	6.2	Multicarrier Communication: Single carrier versus Multicarrier modulation, Capacity of Non-ideal linear filter channel, OFDM modulation and demodulation in an OFDM system, Spectral Characteristics of Multicarrier signals, Bit and Power allocation in Multicarrier modulation, Peak to Average ratio in multicarrier modulation, Channel coding considerations in Multicarrier modulation. An Overview of multi-carrier CDMA .	
		TOTAL	**52**

Reference Books :-

1. Alberto-Leon Garcia, “Probability and Random Processes for Electrical Engineering”, Pearson Education

2. Simon Haykin, “Digital Communication Systems”, Wiley 2014

3. Bernard Sklar, “ Digital Communications: Fundamentals & Applications”, Pearson Education 2nd Ed.

4. Dr. Kamilo Feher , “Wireless Digital Communication”, Prentice Hall Publication

5. John G Proakis, Masoud Salehi , “Communication Systems Engineering”, Pearson Education , 2nd Ed.

6. John Proakis & Masoud Salehi , “Digital Communication”, McGraw-Hill Education, 5th Ed

7. Simon Haykin “Adaptive Filter Theory”, Prentice Hall Publication 4th Ed.

Research Publications :-

1. Andrew J. Viterbi, “Convolutional codes and their performance in communication systems”, IEEE Transactions on Communications Technology, October 1971 , Pages 751 - 772

2. Y. Sato, “A Method of Self-Recovering Equalization for Multilevel Amplitude-Modulation Systems”, IEEE Transactions on Communications June 1975,vol:23,Issue: 6, Page(s): 679 - 682

3. Seung Hee Han & Jae Hong Lee, “An Overview of Peak-To-Average Power Ratio Reduction Techniques for Multi Carrier Transmission”, IEEE Wireless Communications Journal, April 2005, Pages : 56-65, vol:12 Issue:2

4. R. Prasad & S .Hara, ”An overview of multi-carrier CDMA” , Proc. of IEEE 4th International Symposium on Spread Spectrum Techniques and Applications Publication Year: 1996, Page(s):107-114, vol.1

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1012	Mixed Signal VLSI Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1012	Mixed Signal VLSI Design	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. VLSI Design
2. IC Technology
3. CMOS VLSI Design

Course Objectives:-

1. To make students understand & appreciate analytical approach for design of analog VLSI Design
2. To make students ready for design of coexistence of analog and digital circuit and the system level issues

Course Outcomes:-

1. Tackle with the system level issues for mixed VLSI design
2. Explain working of certain basic analog building blocks
3. Design different data converters
4. Implement and comment on performance of Memory devices.
5. State the significance of PLL in mixed VLSI design.

Module No.	Unit No.	Topics	Hrs.
01		Analog and discrete-time signal processing	**06**
		Mixed-Signal Layout Issues, *Floor-planning, Power Supply and Grounding Issues, Guard Rings*	
02		Analog integrated continuous-time and discrete-time filters	**10**
		MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator, Analog multipliers, Loop Filters, Switched Capacitor filter	
03		Special-purpose CMOS circuits.	**08**
		Schmitt trigger, Multi-vibrator Circuits, Ring oscillators, VCO , Voltage Generators	
04		Data Converters	**10**
		Basics of Analog to digital converters (ADC) Basics of Digital to analog converters (DAC) DACs Successive approximation ADCs Dual slope ADCs High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures) High-resolution ADCs (e.g. delta-sigma converters)	
05		Memory	**08**
		ROM, EPROM, F-N model, RAM Memory structure Array Design, sensing and operation of memory cell.	
06		Phase Lock Loop	**10**
		Mixed-Signal layout Interconnects Phase locked loops Delay locked loops. Simple PLL, Charge pump PLL, Non ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
TOTAL			**52**

Reference Books:-

1. CMOS mixed-signal circuit design by R. Jacob Baker, Wiley India, IEEE press, reprint 2008.
2. Design of analog CMOS integrated circuits by Behzad Razavi, McGraw-Hill, 2003.
3. CMOS circuit design, layout and simulation by R. Jacob Baker, Revised second edition, IEEE press, 2008.
4. CMOS Integrated ADCs and DACs by Rudy V. dePlassche, Springer, Indian edition, 2005.
5. Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1981.
6. Design of analog filters by R. Schauman, Prentice-Hall 1990 (or newer additions)
7. An introduction to mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 2008.

Research Publication:-

1. Lanny L. Lewyn, Trond Ytterda, Carsten Wulff, and Kenneth Martin, “Analog circuit Design in Nanoscale Technologies”, Proceedings of the IEEE Vol.97, No.10, October 2009
2. Chi-Sheng Lin, Bin-Da Liu, “A new successive approximation architecture for low-power low-cost CMOS A/D converter,” IEEE Journal of Solid State Circuits, Vol.30, Issue. 1, Pages:54-62, 2003.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1013	Power Electronics System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1013	Power Electronics System Design	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Single phase & three phase AC fundamentals
2. Basic understanding of power electronic devices like SCR, IGBT etc. & commutation techniques
3. Basic working of controlled DC-DC, DC-AC & AC-DC converters, PWM technique for control

Course Objectives:-

1. To make students understand & appreciate analytical approach for design of power electronic systems
2. To make students ready for research & development oriented jobs in academia & industry by introducing recent research advancements in power electronic converters & their applications in distributed generation & smart grids

Course Outcomes:-

1. Ability to apply mathematical modeling concepts to power electronic systems
2. Ability to understand unique nature of computer simulations of power electronic systems
3. Ability to understand new topologies of DC-AC inverters like multi-level & 4-leg inverters
4. Ability to gain in-depth knowledge of AC voltage controllers
5. Ability to understand various issues involved in parallel operation of inverters as part of the distributed generation system
6. Be aware of vital role played by power electronic converters in distributed generation & smart grids

Module No.	Detailed contents	Hours
1	**Analysis of Power Devices** Power transistor, Power MOSFET, SCR, IGBT, design of driver circuits for SCR, BJT, IGBT, MOSFET, selection criteria for switching devices, EMI-EMC issues, protection circuits: Anti saturation protection for BJT and IGBT, overload protection, thermal protection.	**06**
2	**Simulation of Power Electronic Converters and Systems** Brief overview of solving stiff differential equations using ODE solvers like Euler’s method, Heun’s Method, Trapeziodal rule, introduction to circuit oriented simulators like SPICE, MATLAB, SCILAB, comparison of these simulators, study of transformations from 3-phase to stationary reference frame (Clarke transform) and rotating reference frame, decoupled closed-loop control strategies for converters based on these transformations.	**10**
3	**Modeling and Control of Power Electronic Systems** Concept of zero-order hold (ZOH), first-order hold (FOH) and second-order hold (SOH) elements, energy factor, models of AC-DC, DC-AC, AC-AC and DC-DC converters as simple ZOH, FOH and SOH, PI control for AC-DC converters, PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis.	**08**
4	**Inverters (DC-AC Converters)** Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques), neutral point clamped inverter, study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters: droop, and master & slave control.	**10**
5	**AC Voltage Controllers** On-Off control, phase control, single-phase full wave analysis with R & R-L load, input power factor, three-phase full wave controller with R-load, static switches.	**08**
6	**Grid Interface of Renewable Energy Sources** Inverter interfacing control strategies for transferring wind and solar energy to grid, instantaneous power theory, reactive power control, synchronization with grid using phase-locked loop, concept of distributed generation system, microgrids, smart grids.	**10**
	TOTAL	**52**

Reference Books :-

1. N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.

2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.

3. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer USA, 2001.

4. F. L. Luo, H. Ye, M. H. Rashid, Digital Power Electronics & Applications, Elsevier Academic Press, USA, 2005.

5. H. Akagi, E. H. Watanabe, M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press/John Wiley & Sons Ltd., USA, 2007.

6. Q.-C. Zhong, T. Hornik, Control of Power Inverters in Renewable Energy And Smart Grid Integration, IEEE Press/John Wiley & Sons, Ltd., USA, 2013.

Research Publications :-

1. J.-S. Lai & F. Z. Peng, Multilevel converters – A new breed of power converters, IEEE Transactions on Industry Applications, vol. 32, no. 3, pp. 509-517, May/Jun 1996.

2. T. Kawabata and S. Higashino, Parallel operation of voltage source inverters, IEEE Transactions on Industry Applications, vol. 24, no. 2, pp. 281–287, 1988.

3. W. C. Lee, T. K. Lee, S. H. Lee, K. H. Kim, D. S. Hyun, and I. Y. Suh, A master and slave control strategy for parallel operation of three-phase UPS systems with different ratings, Proceedings of the 19th Annual IEEE Applied Power Electronics Conference & Exposition, (Anaheim, California, USA), pp. 456–462, Feb. 2004.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1011	Advanced Processor Architectures-I	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1011	Advanced Processor Architectures-I	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Organization

Course Objectives:-

1. To outline the various factors that contributes to processor performance.
2. To understand the hardware & software enhancements that lead to improved computing experience.
3. To elaborate on the importance of parallelism in processor systems.
4. To analyze issues that present constraints to increasing processor power.

Course Outcomes:-

1. Explain the protection mechanism employed in advanced processors.
2. Describe various enhancements in advanced processor architectures leading to high performance
3. Analyze the complexities in pipeline design
4. Describe issues dealing with parallelism in computing systems.

Module No.	Unit No.	Topics	Hrs
1		**Performance Metrics**	**04**
	1.1	Processor performance equation	
	1.2	Energy and power within a microprocessor and power-reduction techniques	
	1.3	Designing for increasing performance of a Computer	
	1.4	Trends in Cost, Dependability, Benchmarking	
2		**X86 Protection Mechanism**	**12**
	2.1	Protected mode register set	
	2.2	Segmentation in protected mode, Segment Descriptors	
	2.3	Virtual memory management, Address Translation	
	2.4	Privilege levels, Protection rules, Gate descriptors	
	2.5	Multi-tasking and task switching mechanisms	
	2.6	Paging	
3		**Architectural Enhancements**	**12**
	3.1	CISC and RISC processors	
	3.2	Pipelined processors	
	3.3	Superscalar Architectures	
	3.4	Out-of-Order Execution	
	3.5	VLIW processors	
	3.6	Super-pipelining, Branch Prediction logic	
4		**Case Study on the Pentium processor**	**08**
	4.1	Architecture	
	4.2	Register Organization	
	4.3	Instruction pairing, Split-line access mechanism	
	4.4	Branch Prediction logic	
	4.5	On-chip cache organizations, Write-Once policy, Cache coherence	
5		**Pipelining concepts**	**08**
	5.1	Pipeline performance	
	5.2	Arithmetic pipelines	
	5.3	Hazards, Detection logic and minimization techniques	
	5.4	Dynamic Instruction scheduling	
	5.5	Pipeline scheduling theory	
6		**Parallelism**	**08**
	6.1	Amdahl's law	
	6.2	Instruction-level parallelism (ILP), Thread-level parallelism (TLP)	
	6.3	Symmetric multi-processors(SMP),Multi-threading	
	6.4	Multi-processor Organizations, Multi-core processors (CMP)	
	6.5	Clusters, Non-Uniform memory access (NUMA)	
	6.6	Vector Computation, Graphic processing units(GPU)	
TOTAL			**52**

Reference Books :-

1. J.L. Hennessy, and D.A. Patterson, Computer Architecture: A quantitative approach, Fifth Edition, Morgan Kaufman Publication, 2012.

2. Walter A. Triebel, The 80386DX Microprocessor, Prentice-Hall International Editions.

3. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition, Pearson Publications.

4. Don Anderson, Tom Shanley, Pentium Processor System Architecture, Second Edition, Mindshare Inc.

5. M.R. Bhujade, Parallel Computing, Second Edition, New-Age International.

6. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.

Research Publications :-

1. M.D. Hill, Michael Marty, "Amdahl's Law in the Multi-core era", Computer, Volume 41, Issue 7, 2008, ISSN :0018-9162 , Pgs. 33-38.

2. J.L. Hennessy, " VLSI Processor Architecture", IEEE Transactions on Computers ,Volume C-33, Issue:12 Pgs. 1221-1246.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1012	Network & System Administration	04	---	---	04	---	---	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1012	Network & System Administration	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Communication Networks

Course Objectives:-

1. To create ability for designing, administrating small & medium networks
2. To create ability for automating system administration tasks

Course Outcomes:-

1. Ability to manage users, files & software on computer system installation consisting of clients & servers
2. Ability to install & configure networking services for intranet & internet domains
3. Ability to administer network security policies in LINUX
4. Ability to design small & medium size IT infrastructure organization
5. Ability to develop scripting mechanisms & automated scripts to perform complicated administration tasks
6. Ability to deploy systems to manage large amounts of data for wide variety of users

Module No.	Topics	Hrs.
1	**Foundation Elements** Hardware components, capacity planning, namespaces, data integrity, policies and ethics	08
2	**Service Provisioning** Domain name services, collaborative communication, backups and restoration, remote access, remote deployment, web services	10
3	**Network Security** Organizational profile, SMA segment, large company e-commerce web sites, large universities, case studies based on above	08
4	**System Scripting** Shell scripting, BASH, CSH, python scripting for system administration, PHP scripting for web interfaces	12
5	**Data Centers** Locational preferences, security concerns in physical and remote access, power and temperature concerns, tools, supplies and SLA	08
6	**Case Studies** Case studies based on capacity planning and data centers	06
TOTAL		**52**

Reference Books :-

1. The practice of System and Network Administration (2nd Edition), Thomas A Limoncelli, Christina J Hogan, and Strata R Chalup, Addison Wesley, ISBN 0-321-49266-8

2. Unix and Linux System Administration Handbook (4th Edition), Evi Nemeth, Garth Snyder, Trent R Hein, Ben Whaley, Prentice Hall, 2011, ISBN: 10: 0-13-148005-7

3. Essential System Administration (3rd Edition), A Frisch, O’Reilly, 2002, ISBN: 10: 0-596-00342-9

4. Linux Administration - A Beginners Guide, (6th Edition), Wale Sayinka, McGraw Hill, 2012, ISBN: 10:0-07-176758-4

5. TCP/IP Network Administration (3rd Edition) C Hunt, O’Reilly, 2002, ISBN: 10: 0-596-00297-1

6. Learning Python, 5th Edition Mark Lutz,O’Reilly,ISBN-13: 978-1449355739

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1013	Modeling of Microelectronics Devices	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1013	Modeling of Microelectronics Devices	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Electronic devices: Operation and Characteristics

Course Objectives:-

1. To learn & apply basic concepts of semiconductor physics relevant to electronic devices
2. To analyze & explain operation of semiconductor devices in terms of their physical structure
3. To estimate various device parameters & their measurement
4. To describe & use the device & circuit models of semiconductor devices of varying level of complexity

Course Outcomes:-

1. Ability to apply & explain basic semiconductor concepts applicable to the devices
2. Ability to describe the underlying physics & principles of operation of various devices
3. Ability to create & apply linear incremental equivalent circuit models for BJT & MOSFET
4. Ability to determine parameter values for large signal & incremental linear equivalent circuit models for the p-n diodes, BJT & MOSFET based on knowledge of device structure, dimensions & bias conditions

Module No.	Unit No.	Topics	Hrs.
1	**Basic Semiconductor Physics**		10
	1.1	Review of quantum mechanics,	
	1.2	Electrons in periodic lattices, Ek diagrams, Quasi-particles in semiconductors, electrons, holes and phonons	
	1.3	Boltzmann transport equation and solution in the presence of low electric and magnetic fields - mobility and diffusivity	
	1.4	Carrier statistics; Continuity equation, Poisson's equation and their solution; High field effects: velocity saturation, hot carriers and avalanche breakdown	
2	**Semiconductor Junction**		10
	2.1	p-n junction action, Abrupt junction, Linearly graded junction, Static IV Characteristics of p-n junction, Electrical breakdown in p-n junctions	
	2.2	Dynamic behaviour of p-n junction diode	
	2.3	Majority carrier diodes	
	2.4	Schottky, homo- and hetero-junction band diagrams and I-V characteristics	
	2.5	Small signal switching models;	
	2.6	Two terminal and surface states devices based on semiconductor junctions.	
3	**Modeling Bipolar Device Phenomena**		08
	3.1	Injection and Transport Model	
	3.2	Continuity Equation	
	3.3	Transistor Models: Ebers - Moll and Gummel Poon Model	
	3.4	SPICE modeling, temperature and area effects	
4	**MOSFET Modeling**		10
	4.1	Introduction, Inversion Layer,	
	4.2	Threshold Voltage	
	4.3	Gradual Channel Approximation, MOS Transistor Current	
	4.4	Temperature, Short channel and Narrow Width Effect	
	4.5	Characterization of MOS capacitors: HF and LF CVs	
	4.6	Models for Enhancement, Depletion Type MOSFET	
	4.7	CMOS Models in SPICE	
	4.8	Quasi-static compact models of MOS transistors;	
	4.9	Measurement of MOS transistor parameters	
5	**Modeling of Hetero Junction Devices**		08
	5.1	Band gap Engineering	
	5.2	Band gap Offset at abrupt Hetero-junction	
	5.3	Modified current continuity equations	
	5.4	Hetero Junction bipolar transistors (HBTs), Si-Ge	
6	**Monte Carlo Particle Modeling of Semiconductor Devices**		06
	6.1	The Monte Carlo method	
	6.2	Application of Monte Carlo techniques to device modeling	
		TOTAL	**52**

Reference Books :-

1. M. S. Tyagi, "Introduction to Semiconductor Materials and Device", John Wiley & sons, 1991
2. Ben G. Streetman & S. K. Bannerjee, "Solid State Electronic Devices" 6th edition, Prentice Hall
3. Richard S. Muller & Theodore I. Kummins, "Device Electronics for Integrated Circuits", John Wiley & Sons, 2nd edition (1986)
4. A. S. Grove, "Physics & Technology for Semiconductor Devices", McGraw Hill, 3rd edition (2007)
5. Donald A. Neamen, "Semiconductor Devices & Physics", McGraw Hill, 3rd edition (2007)
6. M. H. Rashid, "SPICE for Circuits & Electronics", Prentice Hall (1995)
7. A. Vladimirescu, "The SPICE Book", John Wiley & Sons, New York (1994)

Research Publications :-

1. Christopher M. Snowden, "Semiconductor Device Modeling" Rep. Prog. Phys. Vol. 48, pp. 223-275

2. C. Moglestue, 'Monte Carlo particle modeling of small semiconductor devices" Computer Methods in Applied Mechanics & Engineering Vol. 30 (1982) pp. 173-208; North – Holland Publishing

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1014	Modeling & Simulation	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks							
		Internal Assessment			End Sem Exam	Term Work	Practical	Oral	Total
		Test 1	Test 2	Average					
ELXDLO1014	Modeling & Simulation	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Laplace & Inverse Laplace Transform with their properties
2. Z-transform & Inverse Z-transform with their properties
3. Fourier & Inverse Fourier Transform with their properties
4. Concept of transfer function
5. Fundamentals of linear ordinary differential equations (ODEs)

Course Objectives:-

1. To present concepts of modeling & simulation applicable to various domains of engineering & science
2. To provide theoretical concepts, methods & simulation
3. To gain solid foundation & associated experience for constructing, simulating & analyzing models

Course Outcomes:-

1. Ability to model deterministic systems and differentiate between nonlinear and linear models
2. Ability to understand and appreciate the modeling of distributed parameter systems
3. Ability to understand the definition of simulation & how to develop & analyze simulation model
4. Ability to numerically simulate ordinary differential equations and deterministic systems
5. Ability to correctly design, analyze and interpret the results using simulation

Module	Topic	Hrs.
1	**Introduction to Philosophy of Modeling** Concept of system; Classification of Systems: Linear Systems, Time-Varying vs. Time-Invariant Systems, Lumped vs. Distributed Parameter Systems, Continuous- and Discrete-Time Systems, Deterministic vs. Stochastic Systems, Hard and Soft Systems; Analysis of Systems; Large and Complex Applied System Engineering: A Generic Modeling; Necessity of System Modeling; Characteristics of Models; Trade-offs involved in modeling process; model benchmarking and validation; brief introduction to different types of Modeling methods: First principles, data-driven models, static and dynamic modeling, Linear Regression, Least Squares Method.	08
2	**First Principles Modeling of Deterministic Systems** Lumped parameter modeling using ordinary differential equations; physical understanding of initial conditions and their effects on system response; natural and forced response, transfer functions; stability; dynamic properties using transfer function approach; State space models; Solution of State Equations; Controllability; Observability, examples of systems RLC circuits; Modeling of diodes and transistors; Modeling of power electronics circuits; Mechanical systems: Translational and rotational; electromechanical systems.	10
3	**Data Driven Modeling of Deterministic Systems** System as a black box; comparison between first principles and data-driven modeling; necessity for data-driven modeling; time-domain identification of linear systems; concept of difference equation and discrete transfer function; sampling time; various excitation signals like impulse, step, ramp, sinusoidal, pseudo-random binary signal, their statistical properties; concept of persistently exciting signals, de-trended data; various methods/structures of system identification: ARX, ARMAX, and output error, least-squares method, model validation, frequency-domain identification using Bode plot, application of these techniques to simple RLC and mechanical systems.	10
4	**Modeling of Distributed Parameter Systems** Examples of distributed parameter systems: heat conduction, turbulence, diffusion, transport in semiconductors, polymers; concept of infinite-dimensional systems; introduction to linear partial differential equations (PDEs); initial boundary value problem (IBVP); solution using separation of variables method for simple diffusion and other processes with simple geometry; finite difference method for numerical solution of PDEs; concept of multiphysics systems, necessity for multiphysics modeling, examples, introduction to various multiphysics simulation tools.	10
5	**Simulation of Physical Systems** Introduction; need for simulation; difference between simulation and emulation; Advantages of Simulation; When to Use Simulations; How Simulations Improve Analysis and Decision Making; Applications of Simulation; Numerical Methods for Simulation; The Characteristics of Numerical Methods; Comparison of Different Numerical Methods; Errors during Simulation Numerical Methods, introduction to different type of simulation software.	08
6	**Verification & Validation of Simulation Models & Optimization** Model building, verification and validation; concept of model benchmarking; Verification of simulation models; Calibration and validation of models; difference between the best model and the feasible model; various optimization techniques used for Simulation and model validation.	06
	TOTAL	**52**

Reference Books :-

1. D. K. Chaturvedi, Modeling and Simulation of Systems using Matlab / Simulink, CRC Press, USA, 2009.

2. D. G. Luenberger, Introduction to Dynamic Systems: Theory, Models, & Applications, First Edition, John Wiley & Sons, USA, 1979.

3. R. L. Burden and J. D. Faires, Numerical Analysis, 9th Edition, Cengage Learning, 1993.

4. J. Lewis, Modeling Engineering Systems: PC-Based Techniques and Design Tools (Engineering Mentor Series), Surber Press, USA.

5. Y. W. Kwon, Multiphysics and Multiscale Modeling: Techniques & Applications, CRC Press, USA, 1996

6. L. Ljung, System Identification: Theory for the User, Prentice Hall, USA, 1999.

Research Publications :-

1. Report by Argonne National Laboratory (Mathematics & Computer Science Division), USA, Multiphysics Simulations: Challenges and opportunities, 2012.

2. S. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, USA, 1993

3. L. Ljung, Perspectives on system identification, Annual Review in Control (ScienceDirect) Vol. 34, Issue 1, pp. 1-12 (2010)

4. T. Lingefaard, Faces of mathematical modeling, Zentralblatt für Didaktik der Mathematik (ZDM) – Mathematics Education, Vol. 38, Issue 2, pp. 96-112, April 2006.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1015	Advanced Digital Image Processing	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1015	Advanced Digital Image Processing	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Digital Image Processing

Course Objectives:-

1. To understand the principles of advanced digital image processing
2. To understand the concepts of latest image compression standards
3. To study advanced techniques of image classification & restoration
4. To learn & appreciate image reconstruction & computer tomography (CT)
5. To acquire working knowledge in the field of remote sensing & steganography

Course Outcomes:-
1. Ability to understand & appreciate latest image compression standards for still & video images
2. Ability to gain adequate knowledge of image classification techniques
3. Ability to understand working principles of several important applications of digital image processing
4. Ability to interpret & analyze information from remote sensed images

Module No.	Unit No.	Topics	Hrs.
1	**Image Compression Techniques**		**10**
	1.1	Compression based on DCT and Wavelet transform	
	1.2	JPEG 2000 and video compression standards	
2	**Image Classification techniques**		**10**
	2.1	Patterns and pattern classes	
	2.2	Minimum distance classifier	
	2.3	Optimum statistical Bayes classifier for Gaussian pattern classes	
3	**Image Restoration**		**08**
	3.1	Image degradation models, Noise models	
	3.2	Noise probability density functions	
	3.3	Estimation of noise parameters	
	3.4	Inverse filter and Wiener filter	
4	**Image Reconstruction**		**10**
	4.1	Image reconstruction from projections	
	4.2	Principle of computer tomography	
	4.3	Radon transform and Fourier slice theorem	
	4.4	Reconstruction using parallel beam filtered back propagation	
5	**Introduction to remote sensing, information extraction from remote sensing images**		**08**
	5.1	Characteristics of Multispectral Scanner System (MSS)	
	5.2	Image centered and data centered information extraction	
	5.3	Spectral factors in remote sensing	
	5.4	Spectral signatures	
	5.5	Types of remote sensing systems and scanners	
6	**Applications of Image Processing**		**06**
	6.1	Image Fusion	
	6.2	Steganography	
		TOTAL	**52**

Reference Books :-

1. Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education

2. Robert Schowengerdt, "Remote sensing modules and methods for Image processing" Elsevier

3. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 2007

4. Milan Sonka, Vaclav Hlavac & Roger Boyle, "Image Processing, Analysis, Machine Vision", 3rd edition, Brooks Cole

Research Publications :-

1. A. J. Roses, W. K. Pratt, G. S. Robinson "Interframe cosine transform image coding" IEEE Transactions on Communications, vol. COM-25, Nov. 1977, pp. 1329-1339.

2. Valdimir S. Petrovic Costas S. Xydeas, Gradient-Based Multiresolution Image Fusion, IEEE Transactions on Image Processing, Vol. 13, No. 2, February 2004, pp. 228-237

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO1011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction	05

	of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO1012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO1013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today’s business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07

06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, “Taguchi Technique for Quality Engineering,” McGrawHill
7. Madhav S Phadke, “ Quality Engineering using Robust Design,” Prentice Hall

Course Code	Course Name	Credits
ILO1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO1016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO1017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management.	06

	Applications of GIS, Remote sensing and GPS in this regard.	
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILOS 1018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons

4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL1011	Advanced Communication Techniques Laboratory – I	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXL1011	Advanced Communication Techniques Laboratory – I	---	---	---	---	25	---	25	50

Suggested List of Experiments (Any six) :-

1. Generating and processing of random signals
2. Simulation of communication systems with AWGN channels (BER)
3. Introduction to Monte-Carlo methods
4. Multipath fading channels – simulation of Raleigh and Ricean Channels
5. Simulation of CDMA system.
6. Simulation of OFDM system.
7. Equalizers – Simulation of LMS algorithm
8. Simulation Viterbi decoding algorithm
9. Simulation of Turbo Encoder and Decoder
10. Simulation of LDPC Encoder.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL1012	Mixed Signal VLSI Design Laboratory – II	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXL1012	Mixed Signal VLSI Design Laboratory – II	---	---	---	---	25	---	25	50

Suggested List of Experiments (Any six) :-

Students will have to perform at least one experiment on each module and submit certified journal having a minimum of 8 experiments.

Module No.	List of Experiments
1	Supply and ground bounce determination
2	Switch capacitor Filter Analog Multiplier
3	Schmitt Trigger Ring oscillator
4	ADC based on charge distribution Delta-sigma converters
5	ROM Implementation Sensing amplifier Operation of Memory cell
6	PLL Implementation DLL Implementation

SEMESTER II

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2021	Digital Design with Reconfigurable Architecture	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC2021	Digital Design with Reconfigurable Architecture	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Digital Circuits & Design

Course Objectives:-

1. To teach students to understand, analyze & design finite state machines (FSM)
2. To train students in writing VHDL code of combinational & sequential circuits
3. To prepare students to synthesize & simulate FSM using hardware description languages (HDL)
4. To motivate students to use reconfigurable devices & make them competent to employ FPGA to build big systems

Course Outcomes:-

1. Ability to analyze & design FSM
2. Ability to use hardware description languages for simulation & synthesis
3. Ability to understand fundamentals of HDL which is essential in successful design of digital systems
4. Ability to understand FPGA architecture & compare different approaches to solving basic problems in programmable logic devices
5. Ability to design complex digital systems on FPGA

Module No.	Topic	Hrs.
1	**State Machines Design**	08
	Mealy and Moore machines, Clocked synchronous state machine design, State reduction techniques, State assignment, Clocked synchronous state machine analysis. Sequence detector, Odd/even parity checker for serial data.	
2	**Hardware Description Language VHDL**	14
	Introduction, Code structure, Data types, Concurrent and sequential codes, Signals and variables. Examples like Multiplexers, De-multiplexers, Adder, Flip Flops, Counters, Registers .	
3	**Design of Finite State Machines (FSM) using VHDL**	12
	VHDL code for Moore, Mealy type FSMs, Serial adders, ASM charts, traffic light controller, vending machines.	
4	**System Design**	11
	Bit counting circuits, serial and parallel multipliers, dividers, implementation of Booth's algorithm, MAC design.	
5	**Programmable Logic Devices**	03
	PLDs, CPLD, SRAM based FPGA architecture, Spartan II.	
6	**Simulation and Synthesis**	04
	Functional simulation, timing simulation, logic synthesis, RTL.	
TOTAL		**52**

Reference Books :-

1. John Wakerley, "Digital Design Principles & Practices" Pearson Publication, 3rd edition
2. Volnei A. Pedroni, "Circuit Design with VHDL" MIT Press (2004)
3. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic Design" McGraw Hill, 2nd edition
4. P. J. Ashenden, "The students guide to VHDL" Elsevier (1999)
5. Wayne Wolf, "FPGA Based System Design" Pearson Education
6. Xilinx online resources – www.xilnix.com

Research Publications :-

1. Fayez Elguibaly, " A Fast Parallel Multiplier –Accumulator using the Modified Booth Algorithm", IEEE Transaction On Circuit And Systems –II, Analog And Digital Signal Processing, Vol 47, No. 9. Sept 2000.
2. Paul Chow, Soon Ong Seo, Jonathan Rose, Kevin Chung, Gerard Paez-Monzon, Immanuel Rahardja," The Design of SRAM-Based Field Programmable Gate Array-Part II: Circuit Design and Layout," IEEE Transaction on Very Large Scale Integration (VLSI) System, Vol. 7, No. 3. Sept 1999.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2022	Real Time System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC2022	Real Time System Design	20	20	20	80	---	---	---	100

Course Pre-requisites :-

1. Microprocessor and Peripherals
2. Microcontroller & Applications
3. Embedded system

Course Objectives:-

1. To teach the fundamentals of real time systems, applicability of RFID technology
2. To study the ARM Cortex-M3, the industry leading 32-bit processor for low power, cost sensitive, highly deterministic embedded applications
3. To achieve an understanding of the real time concepts with embedded operating systems
4. To apply hardware and software knowledge to develop real time embedded system according to requirement and constraints

Course Outcomes:-

1. The student will understand basic structure of a real time system and can address various issues in hardware-software co-design.
2. The student will exhibit the knowledge of Implementation of the system with industry leading microcontroller and other hardware components.
3. The student will demonstrate the ability for designing software using commercial real time operating systems.
4. The student will be capable of demonstrating the designing of the real time system according to requirement and constraints

Module No.	Topics	Hrs.
1	**Introduction** Typical Real Time Applications, structure of a real time system, Hard Versus Soft Real Time Systems, A Reference Model, Characterizing real time systems and tasks, issues in real time computing, hardware/software co-design, interrupt latency, Capabilities of commercial Real Time Operating Systems.	04
2	**RFID: Technology and Applications** Overview of RFID:–Reader-tag, potential applications; RFID Technology: – RF communications, Reader/Tag protocols – Middleware architecture; EPC standards **Case study**: Enabling real-time decisions, PINES architecture overview, EPC Model: Internet of Things. RFID Business Aspects, Security and Privacy.	04
3	**Hardware Architecture** Cortex-M3 Basics, Implementation Overview, Memory Systems, Exceptions, The Nested Vectored Interrupt Controller and Interrupt Control, Interrupt Behaviour, Cortex-M3 Programming, Embedded OS Support, The Memory Protection Unit, Other Cortex-M3 Features, I/O Interfacing, Communication protocols, Device driver: Concepts, Module utilities, Driver methods, Device driver for LED, Keyboard, LCD	12
4	**Real Time System Concepts with Embedded OS.** Real time kernel, Task Management, Memory Management, Time Management, Inter-Task communication and Synchronization, Issues in multitasking, Real Time Scheduling for uniprocessor systems, Critical section, IPC through semaphores, Mutex, Mailbox, Message-Queues, pipes or event Flags using µC/OS-II:Task assignment and real time scheduling in multiprocessor systems, Multiprocessor Priority-Ceiling protocol, Resource Access Control and Synchronization.Embedded Linux: using Linux kernel for implementing kernel objects in real time systems, RTLinux Modules, POSIX threads	12
5	**Android operating System** Introduction to Android technology, Structure of Android applications, Data stores, Network services and APIs, Intents, Content Providers and services, Advance Operations with Android, Telephony and SMS, Audio Video using the Camera, Project Discussion on Android.(Porting on Cortex-M3), Generating Android Application.	10
6	**Case Studies** Requirement Analysis, Specifications, Modelling techniques, Testing and Debugging. Database applications, process control applications, robotics, wireless/Network applications.	10
TOTAL		**52**

Reference Books :-

[1] Jane W.S.Liu, "Real-Time Systems", Eighth Edition, Pearson Education, Inc. © 2009, 2000, Publisher, Dorling Kindersley (India) Pvt. Ltd.
[2] C.M.Krishna, Kang.G.Shin, "Real-Time Systems", The McGraw-Hill companies ©1997, Publisher, TATA McGraw-Hill Edition 2010
[3] Dennis E. Brown,"RFID Implementation", The McGraw-Hill companies ©2007, Publisher, TATA McGraw-Hill Edition
[4] Joseph Yiu, "The Definitive Guide to the ARM CORTEX-M3", Second Edition, ©2007, 2010 Elsevier Inc. Forward by Paul Kimelman@2010, Texas Instruments Incorporated.
[5] Jean J. Labrossy, "µC/OS-II, The Real Time Kernel", Lawrence: R&D Publications.
[6] Embedded Linux primer, second edition, Christopher Hallinan, Pearson publication

Research Publications:

1. Lui Sha, Raghunathan Rajkumar and John Lehoczky,"**priority inheritance protocol: an approach to real time synchronization**", IEEE transactions on computers, vol 39, No.9, September 1990.
2. Almut Burchard, Jorg Liebeherr, Yingfeng Oh, and Sang H. Son, **"New Strategies for Assigning Real-Time Tasks to Multiprocessor Systems**", IEEE transactions on computers, vol. 44, no. 12, December 1995

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
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<tr><td>ELXC2023</td><td>Advanced Signal Processing</td><td>04</td><td>---</td><td>---</td><td>04</td><td>---</td><td>---</td><td>04</td></tr>
</table>

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<tr><td>ELXC2023</td><td>Advanced Signal Processing</td><td>20</td><td>20</td><td>20</td><td>80</td><td>---</td><td>---</td><td>---</td><td>100</td></tr>
</table>

Course Pre-requisites:-

1. Signals & Systems
2. Digital Signal Processing
3. Probability & Random Processes

Course Objectives :-

1. To understand DSP techniques in different fields of modern-day applications
2. To study multi-rate DSP algorithms & filter bank analysis for real world applications
3. To develop a solid foundation in linear prediction analysis & optimum filtering concepts
4. To learn thoroughly RMS & LMS algorithm which are at the heart of adaptive systems
5. To gain deep insight into spectrum estimation algorithms

Course Outcomes:-

1. Ability to apply multi-rate processing techniques in practical applications
2. Ability to design optimum filters suited for different applications
3. Ability to design & simulate adaptive systems
4. Ability to extract information from spectral analysis of signals
5. Ability to design & test signal processing algorithms for various tasks

Module No.	Unit No.	Topics	Hrs.
01		**Introduction and Review**	**04**
	1.1	Basic DSP examples in block diagrams, Typical DSP in real world applications.	02
	1.2	Review of FIR & IIR filters, Sampling and Reconstruction of signals, Analog to digital and Digital to analog conversions.	02
02		**Multirate Digital Signal Processing**	**12**
	2.1	Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D .	03
	2.2	Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion.	03
	2.3	Sampling rate conversion of band pass signal, sampling rate conversion by arbitrary factor, Applications of multirate signal processing.	03
	2.4	Digital filter banks, Two channel Quadrature Mirror filter banks.	03
03		**Linear Prediction and Optimum filters**	**12**
	3.1	Random signals, Correlation functions, Power Spectra, Innovations representation of a Stationary random Process	03
	3.2	Forward and Backward Linear predictions.	03
	3.3	Solution of Normal equations. The Levinson-Durbin Algorithm, The Schur Algorithm. Properties of the Linear Prediction Error Filters.	03
	3.4	AR lattice and ARMA Lattice Ladder filters. Wiener filters for filtering and Prediction	03
04		**Adaptive Digital Filters**	**10**
	4.1	FIR adaptive filters, Steepest descent adaptive filter, LMS algorithms, Normalized LMS, Application in noise cancellation.	04
	4.2	Adaptive Recursive filters.	04
	4.3	Recursive Least squares algorithms.	02
05		**Power Spectrum Estimation**	**08**
	5.1	Estimation of spectra from finite duration observations of signals.	02
	5.2	Nonparametric methods for power spectrum estimation.	02
	5.3	Parametric methods for power spectrum estimation.	04
06		**Applications of DSP**	**06**
	6.1	Biomedical applications, ECG signal analysis, QRS template, QRS detection methods etc.	03
	6.2	Speech processing applications, Wideband and narrowband spectrograms.	03
		TOTAL	**52**

Reference Books :-

1. Digital Signal Processing Principles, algorithms & applications, John. G. Proakis, D.G.Manolakis. 4/e

2. Digital Signal Processing, “A Practical approach”, Emmanuel C Ifeachor & B.W.Jervis. Pearson

3. Digital Signal Processing. A computer based approach, S.K.Mitra, Tata Mc Graw Hill

4. Statistical Digital Signal Processing, Monson. H .Hayes, Wiley India

5. Introduction to Digital Speech Processing, L.R. Rabiner & R.W Schafer, Pearson

6. Discrete time Signals Processing, Oppenheim & Schaffer, Pearson

Research Publications :-

1. P. Vaidyanathan (1990) . ”Multirate Digital filters, Filter banks, Polyphase network and applications: A tutorial” Proc. IEEE vol 78, No 1,pp 56-90.

2. Schoeder M.R (1985) “Linear predictive coding of speech: Review and current directions” IEEE Communication Magazine vol. 23, pp. 54-61

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2021	Advanced Computer Architectures-II	04	---	---	04	---	---	04

Subject Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2021	Advanced System Architectures-II	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Organization & Processor Architectures

Course Objectives:-

1. To outline the various factors those contribute to system design
2. To understand the design flow of application specific processors
3. To elaborate on the importance of VLIWDSP processors & soft-core processors
4. To analyze issues & pitfalls in reconfigurable processor design with FPGA

Course Outcomes:-

1. Ability to explain various types of processors & their design flow in detail
2. Ability to describe various concepts of VLIWDSP processors & soft-core processors
3. Ability to analyze the issues in VLIWDSP processor design
4. Ability to describe pitfalls in designing with reconfigurable processors with FP

Module No.	Unit No.	Topics	Hrs.
1		**Computer Architecture Fundamentals**	06
	1.1	A top Level View of Computer functions and Interconnections	
	1.2	Computer Components, Architecture organization	
	1.3	Concepts and Ways of Parallelism	
	1.4	Domain-Specific Processors and Application Specific Processors	
	1.5	Design Considerations	
2		**Processor Design Flow**	08
	2.1	Capturing requirements, Instruction coding	
	2.2	Exploration of Architecture Organizations	
	2.3	Hardware and Software Development	
	2.4	Software tools and libraries	
3		**Memory**	06
	3.1	Semiconductor Memories SRAM, DRAM and organization	
	3.2	Principles of Cache memory, Cache Design	
	3.3	Cache Coherency, MESI Protocol	
	3.4	RAID	
4		**I/O, Peripherals and Operating System**	08
	4.1	Types of I/Os, I/O Interfacing concepts	
	4.2	PCI, PCI-X, PCI-E	
	4.3	Universal Serial Bus(USB)	
	4.4	Operating System Overview, Scheduling	
	4.5	Memory Management in Operating Systems	
5		**VLIW DSP Processor**	12
	5.1	DSP Processor Architecture, DSP-specific requirements	
	5.2	Micro architectural concepts	
	5.3	VLIW and SW programmability	
	5.4	Application specific adaptable core Architecture	
	5.5	Design space Exploration, Complexity of Configurability	
6		**Soft-Core Processors**	12
	6.1	Processor Customization	
	6.2	Microprocessor cores in SOC design, Difference between Microprocessor and SOC	
	6.3	Reconfigurable processors with FPGA	
	6.4	Case study of Reconfigurable structure	
	6.5	Pitfalls in VLIW Architectures	
TOTAL			**52**

Reference Books :-

1. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson Publications.

2. Jari Nurmi, “Processor Design: System-on-Chip Computing for ASICs and FPGAs”, Springer.

3. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.

4. Hennessy JL, Patterson DA (2003) Computer Architecture: A Quantitative Approach.3rd edition. Elsevier Morgan Kaufmann, San Francisco

Research Publications :-

1. Andrea Lodi, Mario Toma, “A VLIW Processor with a Reconfigurable Instruction Set for Embedded Applications”, IEEE Journal Of Solid-State Circuits, Vol. 38, No. 11, November 2003,pp-1876-1886.

2. Lodi A, Cappelli A, Bocchi M, Mucci C, “XiSystem: A XiRisc-based SoC with a Reconfigurable I/O Module”, IEEE Journal of Solid-State Circuits (JSSC), 2006, Vol.41, No.1, pp-85–96.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2022	Wireless & Mobile Networking	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2022	Wireless & Mobile Networking	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Communication Networks

Course Objectives:-

1. To understand the various aspects of Wireless network operation
2. To understand the concept of Ad Hoc Networks
3. To comprehend the usefulness of Wireless Sensor Networks in many applications
4. To understand and analyze various Protocols of MANETS and WSNs.

Course Outcomes:-

1. Students would be able to understand principle of operation of Wireless Networks & its salient features.
2. Students would be the able to comprehend the various issues involved in establishing Mobile Ad Hoc Networks, designing its MAC Protocols.
3. They will have the ability to analyze and compare various Routing Protocols of MANETs.
4. They will have the ability to understand the significance of wireless Sensor Networks and its widespread applications all around us.
5. Students would be exposed to research issues in Next-Generation networks - Cognitive Radio Networks.

Module No.	Unit No	Topics	Hrs
01		**Review of Wireless network operation & Wireless LANs**	**08**
	1.1	Wireless Network operation: topologies: Infrastructure networks and Adhoc networks, Mobility Management – Mobile IP operation of Mobile IP, Discovery, Registration, and Tunneling.	
	1.2	Power control & Power saving Mechanisms in Wireless networks, Energy efficient designs and Energy efficient software approaches	
	1.3	Overview of Wireless LAN: 802.11 Architecture, Medium Access Control: CSMA /CA , DCF , PCF , MAC Frame	
02		**Mobile ADHOC Networks (MANETs)**	**08**
	2.1	Ad hoc wireless networks: Issues in Ad Hoc wireless networks, Issues in designing MAC Protocol for Ad Hoc networks, Classification of MAC protocols	
	2.2	Contention-based Protocols: Contention-based Protocols with reservation mechanisms, Contention-based MAC Protocol with Scheduling mechanisms	
03		**ROUTING PROTOCOLS for Mobile ADHOC Networks**	**12**
	3.1	Routing Protocols for MANETs : Classification of Routing Protocols, Table –driven Routing Protocols: Distance Sequence Distance Vector Routing protocol, Cluster-head Gateway switch routing protocol, On-demand Routing protocols: Dynamic Source Routing Protocol , Ad Hoc On-demand Routing protocols (AODV), Hierarchical Routing Protocols and Power aware Routing protocols	
	3.2	Multicast Routing in MANETs: introduction and Classification of Multicast routing protocols	
	3.3	Transport Layer protocol for MANETs: TCP over Ad Hoc wireless networks : issues and challenges ,QOS in MANETS: issues and challenges	
04		**Introduction to Wireless sensor networks**	**08**
	4.1	Introduction and overview of WSN: Sensor Network Architectural Elements, Basic Wireless sensor technology: Sensor node technology,	
	4.2	Applications of WSN: Category 1 WSNs and Category 2 WSNs Challenges and hurdles in WSN.	
	4.3	Data Gathering ,MAC Protocols for WSN: Schedule based protocols , Random- Access based protocols	
05		**Routing protocols for Wireless sensor networks**	**10**
	5.1	Routing Challenges and Design issues in WSN ,Data Dissemination, Routing strategies in WSN : Proactive , Reactive hybrid strategies	
	5.2	Data centric Routing Protocol: SPIN	
	5.3	Hierarchical Routing protocol : LEACH	
06		**Recent Advances in Wireless networks**	**06**
	6.1	Cognitive Radio Networks : Spectral sensing , white holes, Spectrum management	
	6.2	Open Research Issues in Multi-hop Cognitive Radio Networks	
		TOTAL	**52**

Reference Books :-

1. Kaveh Pahlavan, "Principles of Wireless Networks: A Unified Approach", Pearson Education

2. William Stallings,"Wireless Communications & Networking", 2nd Ed., Pearson Education

3. Siva Ram Murthy & B.S.Manoj, "Ad hoc wireless Networks: Architectures and Protocols "Pearson

4. Sohraby Kazem, Minoli Daniel & Znati Taieb,"Wireless Sensor Networks: Technology, Protocols and Applications", WILEY student Edition

5. Zhao Feng & Guibas Leonidas,"Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann

Research Publications :-

1. Ian F. Akyildiz . Et al. ,"Wireless sensor networks: a survey", Elsevier Journal of Computer Networks 38 (2002) 393–422

2. Kemal Akkaya & Mohamed Younis , "A survey on routing protocols for wireless sensor network" , Elsevier Journal of Ad Hoc Networks 3 (2005) 325–349

3. A. Ghasemi and E. S. Sousa, "Spectrum sensing in cognitive radio networks: Requirements, challenges and design trade-offs," IEEE Communications Magazine, vol. 46, no. 4, pp. 32-39, April 2008.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2023	Nanoelectronics	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2023	Nanoelectronics	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. MOSFET & Microelectronic Concepts
2. Quantum Mechanics

Course Objectives:-

1. To learn fundamental concepts of nanoelectronics including single electron effects & electron transport in nanoscopic system
2. To learn the concept of the quantum dot, the quantum wire, quantum well & nano applications of these structures
3. To gain knowledge on SET & carbon nano tubes in design of transistors
4. To learn basics of ballistics transport & spintronics

Course Outcomes:-

1. Ability to explain concepts of nanoelectronics including single electron effects & electron transport in nanoscopic system
2. Ability to describe concept of the quantum dot, the quantum wire, quantum well & nano applications of these structures
3. Ability to describe various new structures like CNTFET & SET
4. Ability to describe basic of spintronics & spin based devices

Module No.	Unit No.	Topics	Hrs.
1		**Classical particles , classical waves and Quantum Particles**	10
	1.1	Introduction to Nanotechnology	
	1.2	Comparison of classical and Quantum System	
	1.3	Origins of Quantum Mechanics	
	1.4	Electron as particle , electron as wave	
	1.5	Wave packets and uncertainty	
2		**Quantum Mechanics of Electron**	10
	2.1	General Postulates of Quantum Mechanics	
	2.2	Time Independent Schrodinger 's equation	
	2.3	Free electron: One dimensional and three dimensional space, Free electron Gas theory of metals	
	2.5	Partially confined electron. Finite potential well: Finite potential rectangular well, Parabolic well, Triangular well	
	2.6	Quantum Dot, Wires and wells	
3		**Single Electron and few Electron Phenomena and devices**	10
	3.1	Tunneling junctions and application of tunneling	
	3.2	Coulomb Blockade and The single Electron Transistor	
	3.3	Resonant Tunneling Diodes- principle and applications	
	3.4	Carbon Nanotube Transistor(FETs and SETs), Semiconductor Nanowire FETs and SETs	
	3.5	Molecular SETs and Molecular Electronics	
4		**Model of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots**	10
	4.1	Particles Statistics and density of states	
	4.2	Semiconductor heterostructures and Quantum Well	
	4.3	Quantum Wires and Nanowire	
	4.4	Fabrication Techniques for Nanostructures	
5		**Ballistic Transport , and Spin Transport**	12
	5.1	Ballistic Transport: Electron collision and length scale, Ballistic Transport Model ,Quantum Resistance and conductance	
	5.1	Spin Vs charge, AMR, GMR, TMR , The transport of spin	
	5.2	Spin devices- Spin valves, Magnetic tunnel junctions,	
	5.3	Applications – Memories (MRAM, STRAM), Logic device and Microwave Oscillators	
TOTAL			**52**

Reference Books :-

1. George W. Hanson " Fundamental of Nanoelectronics", PEARSON

2. Rainer Waser, "Nano Electronics and Information Technology: Advanced Electronic Materials and Novel Devices", 2nd Edition, Wiley-VCH, 2012.

3. Chonles P. Poole Jr., Frank. J. Owens, “Introduction to Nanotechnology”, John Wiley and Sons, 2009.

4. T. Pradeep, “Nano: The essentials”, Tata McGraw Hill, 2007.

5. Mark A. Ratner, Danill Ratner, “Nano Technology: A Gentle Introduction to the Next Big Idea”, Prentice Hall, 2003

6. Springer Handbook of Nanotechnology ISBN: 978-3-540-35172-6

Research Publications :-

1. Leland Chang, Yang-Kyu Choi, Daewon Ha, Pushkar Ranade, Shiying Xiong, Jeffrey Bokor, “Extremely Scaled Silicon Nano-CMOS Devices”, PROCEEDINGS OF THE IEEE, VOL. 91, NO. 11, NOVEMBER 2003,pp-1860-1873.

2. Thomas Skotnicki, James A. Hutch by, Tsu-Jae King,H.-S. Philip Wong, and Frederic Boeuf,”The End of CMOS Scaling”, IEEE CIRCUITS & DEVICES MAGAZINE, January 2005,pp-16-26.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching Scheme (Hrs)</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Total</th></tr>
<tr><td>ELEXDLO2024</td><td>Mechatronics</td><td>04</td><td>---</td><td>---</td><td>04</td><td>---</td><td>---</td><td>04</td></tr>
</table>

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th></th><th></th><th></th><th></th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem Exam</th><th rowspan="2">Term Work</th><th rowspan="2">Practical</th><th rowspan="2">Oral</th><th rowspan="2">Total</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Average</th></tr>
<tr><td>ELXDLO2024</td><td>Mechatronics</td><td>20</td><td>20</td><td>20</td><td>80</td><td>---</td><td>---</td><td>---</td><td>100</td></tr>
</table>

Course Pre-requisites:-

1. Knowledge of electric circuits & components
2. Analog & digital electronic circuits
3. System dynamics, control & instrumentation
4. Microprocessor based controller
5. Microelectronics

Course Objectives:-

1. To develop an ability to identify, formulate & solve engineering problems
2. To develop an ability to design a system to meet desired needs

Course Outcomes:-

1. Ability to identify examples of mechatronics systems encountered in real life
2. Ability to discuss importance of feedback in controlling physical systems with use of examples
3. Ability to formulate specifications for adopting / designing different components of mechatronics system
4. Ability to identify signal processing that has to be applied to signals in mechatronics systems
5. Ability to conduct a mechatronics design using a structured formal approach
6. Ability to make decisions about components choices taking into account its effect on the choice of other components & performance of the mechatronics system

Module	Topic	Hrs.
1	**Mechatronics Systems Design** Introduction to Mechatronics, Integrated Design Issues in Mechatronics, The Mechatronics Design Process, Mechatronics Key Elements, Applications in Mechatronics	08
2	**Mechatronics Design Approach** Functions of Mechatronic Systems, Division of Functions between Mechanics and Electronics, Improvement of Operating Properties, Addition of New Functions, Ways of Integration, Integration of Components, Integration of Information Processing, Information Processing Systems, Multilevel Control Architecture, Special Signal Processing, Concurrent Design Procedure for Mechatronic Systems	10
3	**Modeling & Simulation of Physical Systems** Operator Notation and Transfer Functions, Block Diagrams, Manipulations, and Simulation, Block Diagram Modeling-Direct Method, Block Diagram Modeling-Analogy Approach, Electrical Systems, Mechanical Translational Systems, Mechanical Rotational Systems, Electrical–Mechanical Coupling	10
4	**Systems Response** System Response, Amplitude Linearity, Fourier Series Representation of Signals, Bandwidth and Frequency Response, Phase Linearity, Distortion of Signals, Dynamic Characteristics of Systems, Zero-Order System, First-Order System, Experimental Testing of First-Order System, Frequency Response of System, System Modeling and Analogies	10
5	**Role of Modeling in Mechatronics Design** Modeling as Part of the Design Process- Phase 1 • Phase 2 • Phase 3 • Phase 4, The Goals of Modeling- Documentation and Communication • Hierarchical Framework • Insights • Analogies • Identification of Ignorance, Modeling of Systems and Signals- Analytical vs. Numerical Models • Partial vs. Ordinary Differential Equations • Stochastic vs. Deterministic Models • Linear vs. Nonlinear	08
6	**Case Studies & Research Trends in Mechatronics** Robocow Mobile Robot for Training Horses, Vision Guidance for Tractors, A Shape Recognition Example	06
TOTAL		**52**

Reference Books :-

1. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, SI Version, 2nd Ed. 2011, Cengage Learning, Published by Global Engineering: Christopher M. Shortt

2. Robert H. Bishop, Mechatronics : an introduction, 2006, published by CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW

3. David G. Alciatore & Michael B. Histand, Introduction to Mechatronics & Measurement Systems, Fourth Edition, 2011 McGraw-Hill

4. John Billingsley, Essentials of Mechatronics, 2006 John Wiley & Sons, Inc., Hoboken, New Jersey

Research Publications:-

1. Lorenzo Fagiano & Trevor Marks, “Design of a Small-Scale Prototype for Research in Airborne Wind Energy,” IEEE/ASME TRANSACTIONS ON MECHATRONICS, VOL. 20, NO. 1, FEBRUARY 2015

2. Ammar Aldaoud, Callum Laurenson, Francois Rivet, Mehmet R. Yuce, and Jean-Michel Redoute, “Design of a Miniaturized Wireless Blood Pressure Sensing Interface Using Capacitive Coupling,” IEEE/ASME TRANSACTIONS ON MECHATRONICS, VOL. 20, NO. 1, FEBRUARY 2015

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2025	Virtual Instrumentation	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2025	Virtual Instrumentation	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Understanding of fundamental principles of instrumentation
2. Basic level course in instrumentation system

Course Objectives:-

1. To understand the features of virtual instrumentation
2. To understand the concepts of graphical programming language
3. To understand the technique of real-time interface
4. To select proper communication interface
5. To apply knowledge in some real life application in field of biomedical & industrial automation

Course Outcomes:-

1. Ability to understand & implement basic VI
2. Ability to test the DAQ card for real-time interface
3. Ability to choose suitable interface for data monitoring, analyzing & communication
4. Ability to design & understand significance of VI in real-time applications

Module No.	Detailed Contents	Hrs.
1	**Virtual Instrumentation** Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.	08
2	**VI Programming Techniques** VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web	08
3	**Data Acquisition Basics** Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.	10
4	**Distributed Virtual Instrumentation** Common Instrument Interfaces: Current loop, RS 232C/RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & industrial applications, VISA and IVI.	08
5	**Tools and Platform** VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.	10
6	**Applications of Virtual Instrumentation** Biomedical, Medical Signal Processing, Real world case studies	08
	TOTAL	**52**

Reference Books :-

1. Virtual Instrumentation Using Labview by Jerome J (Author) PHI

2. Virtual Instrumentation using LABVIEW Principles and practices of graphical programming, 2^{nd} edition, May 2010 by Sanjay Gupta and Joseph John, Tata McGraw Hill Publication

3. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, New York, 1997.

4. PC interfacing for Data Acquisition & process control, by S. Gupta, J.P.Gupta

5. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

Research Publications :-

1. Rahman Jamal, Lothal Wenzel, “The Applicabilityof the Visual Programming Language LabVIEW to Large Real-World Applications” 1995, IEEE, 99-106

2. Željko Obrenovic, Dušan Starcevic, Emil Jovanov, “Virtual Instrumentation”

3. D.S.Benitez, A.Zaidi, A.Fitchet, P.A.Gaydecki and A.P.Fitzpatrick’ “Virtual instrumentationfor clinical assessment of cardiovascular and autonomic function” *IEE Proc.-Sci. Meus. Technol.,Vol. 147, No. 6, November 2000,397-402*

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO2021	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project	8

	audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO2022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	**Enterprepreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	6

	• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**

06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO2028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06

5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO2029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL2021	Digital Design with Reconfigurable Architecture Laboratory – III	---	02	---	---	01	---	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXL2021	Digital Design with Reconfigurable Architecture Laboratory – III	---	---	---	---	25	---	25	50

Suggested List of Experiments (Any six) :-

Students will have to perform at least one experiment on each module and submit certified journal having a minimum of 8 experiments.

Module No.	List of Experiments
1	Design of Mealy machine using ICs. Design of Moore machine using ICs. Analysis of Mealy machine circuit assembled using ICs. Analysis of Moore machine circuit assembled using ICs.
2	Simulation of multiplexer using VHDL. Simulation of register using VHDL.
3	Simulation of Mealy machine using VHDL. Simulation of Moore using VHDL.
4	Simulation of multiplier using VHDL. Simulation of divider using VHDL.
5	Hardware implementation of multiplexer on FPGA kit. Hardware implementation of Mealy machine on FPGA kit. Hardware implementation of Moore machine on FPGA kit. Hardware implementation of multiplier on FPGA kit.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL2022	Advanced Signal Processing Laboratory – IV	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXL2022	Advanced Signal Processing Laboratory – IV	---	---	---	---	25	---	25	50

Course Pre-Requisites:-

1. Basic knowledge of Signals and Systems, DSP.
2. Acquaintance of Simulation languages and software tools.

Course Objectives:-

1. To design and simulate basic DSP systems and multirate systems for practical applications.
2. To design & simulate DSP systems for spectral analysis of signals and optimum filters for different applications
3. To design and simulate adaptive filters for real world applications

Course Outcomes:-

1. Ability to implement basic DSP algorithms and multirate techniques for various situations.
2. Ability to implement optimum filters for real world applications and extract spectral information.
3. Ability to design and test adaptive filter systems for practical applications.

List of Experiments.

1. Basic filtering operations, noise reduction FIR filter, enhancement of ECG signal using notch filtering etc.
2. IIR filter. Simulation of Digital audio equalizer.
3. Biomedical signal processing, ECG signal processing.
4. Algorithms in DTMF tone generation.
5. Oversampling and Analog to digital conversion & resolution.
6. Sampling rate reduction by an integer factor, sampling rate increase by an integer factor.
7. Changing Sampling rate by a non integer factor L/M.
8. Upsampling and Interpolation filter processes in CD audio systems.
9. Noise cancellation using adaptive filters.
10. System modeling using adaptive filters.
11. Line enhancement using linear prediction.
12. Sub-band decomposition and two channel perfect reconstructions QMF bank.

Students are required to perform any six experiments from the above list covering most of the topics in Advanced Signal processing and perform one mini project preferably based on any of the above topics 2, 4, 8 or 12.

SEMESTER III

Course Code	Course Name	Credits
ELXS3031	Seminar	03

Guidelines for Seminar

- Seminar should be based on thrust areas in Electronics and Telecommunication Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the topic and compile the report in standard format and present infront of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.

Seminar should be assessed based on following points

- Quality of Literature survey and Novelty in the topic
- Relevance to the specialization
- Understanding of the topic
- Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.
2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.
3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

SEMESTER III/IV

Course Code	Course Name	Credits
ELXD3031 /ELXD4041	Dissertation I/ Dissertation-II	12+ 15

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
- ➢ Quality of Literature survey and Novelty in the problem
- ➢ Clarity of Problem definition and Feasibility of problem solution
- ➢ Relevance to the specialization
- ➢ Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
- ➢ Quality of Literature survey and Novelty in the problem
- ➢ Clarity of Problem definition and Feasibility of problem solution
- ➢ Relevance to the specialization or current Research / Industrial trends
- ➢ Clarity of objective and scope
- ➢ Quality of work attempted
- ➢ Validation of results
- ➢ Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai

  Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)

AC 14/7/2016
Item No. 4.25

UNIVERSITY OF MUMBAI

Revised Syllabus

For

Master of Engineering

Program: M. E. (Computer Engineering)

Under

FACULTY OF TECHNOLOGY

(As per Choice Based Credit and Grading System)

from

Academic Year 2016-17

From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The M. E. in Computer Engineering programme is offered to students who are interested in advanced learning and research in any area of Computer Science and Engineering. Applicants to this programme are expected to have a background in Computer Science and Engineering or Information Technology.

The objective of the programme is to enable the learner to apply his/her enhanced skill and knowledge at the top research laboratories and companies in the country and even abroad.

The programme is a 72-credit degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

University of Mumbai feels that it is desirable to provide specialized ME programme in Computer Engineering to address the needs of the industry, which today requires more specialized resource in each field.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Subhash K. Shinde

Chairperson,
Adhoc Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

Program Structure for ME Computer Engineering,
(With Effect from 2016-2017)
University of Mumbai)

Semester –I

Course Code	**Course Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Pract**	**Tut**	**Theory**	**Pract**	**Tut**	**Total**
CSC101	Algorithm & Complexity	04	---	---	04	---	---	04
CSC102	Advance Computer Network and Design	04	---	---	04	---	---	04
CSC103	Advanced Operating Systems	04	---	---	04	---	---	04
CSDLO-I	Department Level Optional Course-I	04	---	---	04	---	---	04
ILO-I	Institute Level Optional Course-I	03	---	---	03	---	---	03
CSL101	Computational Laboratory-I	--	02	--	01	---	--	01
CSL102	DEC Laboratory-I	--	02	--	01	---	--	01
Total		19	04	--	21	--	--	21

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**TW**	**Oral/ Pract**	**Total**
		Internal			**End Sem. Exam**	**Exam Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
CSC101	Algorithm & Complexity	20	20	20	80	3	--	---	100
CSC102	Advance Computer Network and Design	20	20	20	80	3	--	---	100
CSC103	Advanced Operating Systems	20	20	20	80	3	--	---	100
CSDLO-I	Department Level Optional Course-I	20	20	20	80	3	--	---	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	---	100
CSL101	Computational Laboratory-I	---	---	---	----	----	25	25	50
CSL102	DEC Laboratory-I	---	---	---	----	----	25	25	50
Total		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,
(With Effect from 2016-2017)
University of Mumbai)

Semester –I

Course Code	Department Level Optional Course-I	Course Code	Institute Level Optional Course-I
CSDLO1011	Logic & Automated Reasoning	ILO1011	Product Lifecycle Management
CSDLO1012	Image Analysis & Interpretation	ILO1012	Reliability Engineering
CSDLO1013	Natural Language Processing	ILO1013	Management Information System
CSDLO1014	Computational Intelligence	ILO1014	Design of Experiments
CSDLO1015	User Experience Design	ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management & Mitigation Measures
		ILO1018	Energy Audit and Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS201	High performance Computing	04	---	---	04	---	---	04
CS202	Data Science	04	---	---	04	---	---	04
CS203	Ethical Hacking and Digital Forensics	04	---	---	04	---	---	04
CSDLO-II	Department Level Optional Course –II	04	---	---	04	---	---	04
ILO-II	Institute Level Optional Course-II	03	---	---	03	---	---	03
CSL201	Computational Laboratory-II	--	02	--	01	---	--	01
CSL202	DEC Laboratory-II	--	02	--	01	---	--	01
Total		19	04	---	21	--	--	21

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC201	High performance Computing	20	20	20	80	3	--	---	100
CSC202	Data Science	20	20	20	80	3	--	---	100
CSC203	Ethical Hacking and Digital Forensics	20	20	20	80	3	--	---	100
CSDLO-II	Department Level Optional Course –II	20	20	20	80	3	--	---	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	--	---	100
CSL201	Computational Laboratory-II	---	---	---	---	----	25	25	50
CSL202	DEC Laboratory-II	---	---	---	---	----	25	25	50
		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	**Department Level Optional Course -II**	**Course Code**	**Institute Level Optional Course-II**
CSDLO2021	Data Storage & Retrieval	ILO2021	Project Management
CSDLO2022	Internet of Things	ILO2022	Finance Management
CSDLO2023	Advance Soft Computing	ILO2023	Entrepreneurship Development and Management
CSDLO2024	Semantic Web & Social Network Analysis	ILO2024	Human Resource Management
CSDLO2025	ICT for Social cause	ILO2025	Professional Ethics and CSR
		ILO 2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS301	Special Topic Seminar	----	06	--	---	03	--	03
CS302	Dissertation-I	---	24	--	---	12	--	12
Total		**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
CS302	Dissertation-I	---	---	---	---	---	100	---	100
Total		---	---	---	----	---	**150**	**50**	**200**

Semester –IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS401	Dissertation-II	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
CS401	Dissertation-II	--	---	---	---	---	100	100	200
Total		**--**	**---**	**---**	**---**	**---**	**100**	**100**	**200**

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	**Algorithm and Complexity**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To analyze the algorithms using space and time complexity.
2. To teach problem formulation and problem solving skills.
3. To acquire knowledge of various applied algorithms.
4. To understand selected topics in algorithms that have found applications in areas such as geometric modelling, graphics, robotics, vision, computer animation, etc.

Course Outcomes: At the end of the course student should be

- Able to prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains
- Able to apply the algorithms and design techniques to solve problems.

Prerequisite: Data structure, Analysis of Algorithms, Set Theory

Sr. No.	**Module**	**Detailed Content**	**Hours**
1	Foundations	• Algorithms, Analysing algorithms, Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis • Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms	4
2	Advanced Design and Analysis Techniques	• Dynamic Programming-Elements of dynamic programming, Matrix-chain multiplication • Greedy Algorithms-Elements of the greedy strategy, Huffman codes • Amortized Analysis-Aggregate analysis, The accounting method, The potential method, Dynamic tables	6

3	Graph Algorithms	• Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra’s algorithm, Difference constraints and shortest paths • All-Pairs Shortest Paths-The Floyd-Warshall algorithm • Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching	8
4	Computational Geometry	• Line-segment properties, Determining whether any pair of segments intersects, • Finding the convex hull, Finding the closest pair of points	8
5	NPC and Approximation Algorithms	• NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems, • Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, The subset-sum problem	10
6	Applied Algorithms	• Number-Theoretic : Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA • String Matching Algorithms :The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Longest common subsequence • Parallel Algorithm: Mesh Algorithm and its applications • Probabilistic Algorithm: Game Theoretic Techniques • Randomized Algorithms: Monte Corlo and Las Vegas algorithms	12

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, PHI, India Second Edition
2. Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms”, Galgotia
3. Rajeev Motwani, PrabhakarRaghavan, “ Randomized Algorithm”, Cambridge University Press

Reference Books:

1. Aho, Hopcroft, Ullman: The Design and analysis of algorithms”, Pearson Education
2. Vijay V. Vajirani, “Approximation Algorithms”,Springer.

3. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI
4. SanjoyDasgupta, Christos Papadimitriou, UmeshVazirani, “Algorithms”, Tata McGraw-Hill Edition

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC102	**Advanced Computer Networking and Design**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To study the problem of congestion control and service integration in TCP/IP networks focusing on protocol design, implementation and performance issues.
2. To understand the principles of network design and enable students to setup, configure and interconnect an IP network.
3. To debate the current trends and leading research in the computer networking area.

Course Outcomes: Learner will able to

- Understand the theoretical issues in protocol design and apply it to Quality of service in networks.
- Understand issues in the design of network processors and apply them to design network systems
- Simulate working of wired and wireless networks to understand networking concepts.
- Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
- Understand the basics of software defined networking and explore research problems in that area.

Sr. No.	Module	Detailed content	Hours
1	**Internetworking**	**Congestion control and Resource allocation**: Issues of Resource Allocation, Queuing Disciplines: FIFO, Fair Queuing, TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery. **Congestion-Avoidance Mechanisms**: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF).	10

2	**Routing:**	IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing.	08
3	**IPv6**	IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols.	06
4	**Network Design:**	Designing the network topology and solutions-Top down Approach: PPDIOO – Network Design Layers - Access Layer, Distribution Layer, Core/Backbone Layer, Access Layer Design, Backbone Network Design, Enterprise LAN Design: Ethernet Design Rules and Campus Design best practices, Virtualisation and Data Center Design, Wireless LAN Design, WAN Design: Traditional WAN Technologies, VPN Design.	14
5	**Ad Hoc Wireless Networks**	MAC Protocols for Ad Hoc Wireless Networks: MACA/W, MACA-BI, DPRMA, MACA/PR. Routing Protocols for Ad Hoc Wireless Networks: DSDV, DSR, AODV, ZRP. Transport Layer: ATCP.	06
6	**Software Defined Networking and OpenFlow**	Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	04

Text Books:

1. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Elsevier, Fourth Edition.
2. Philip M. Miller, *TCP / IP: The Ultimate Protocol Guide Applications, Access and Data Security - Vol 2, Wiley*
3. Pete Loshin, IPv6: Theory, Protocols and Practice, Morgan Kaufmann, 2nd Edition, 2004
4. Anthony Bruno, Steve Jordan, Official Cert Guide: CCDA, Cisco Press,
5. C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and, Prentice Hall, 2004.
6. Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013

Reference Books:

1. William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.
2. James F. Kurose, Keith W. Ross, “Computer Networking, A Top-Down Approach Featuring the Internet”, Third Edition, Addison Wesley, 2004.
3. Pujolle, Software Networks: Virtualisation, SDN, 5G, Security, Wiley,

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC103	**Advanced Operating System**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To learn the architectural differences and issues related to Advanced Operating System.
2. To get a comprehensive knowledge of the distributed systems and Real time operating system.
3. To get a thorough knowledge of database operating systems and cloud operating System.

Course Outcomes: Learner will able to

- Apply the principles and concepts in analyzing and designing Advance Operating System.
- Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
- Analyze the performance and reliability of different Advanced Operating Systems.

Sr. No.	Module	Detailed content	Hours
1	Introduction	• Types of Advanced Operating Systems. • Architectures and design issues of Network operating system, DOS, Middleware, RTS, DBOS. • Introduction to process, Concurrent processes, Critical Section problems, other synchronization problems.	04
2	Distributed operating Systems, Scheduling and synchronization	• Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, Selecting a suitable load sharing Algorithm. • Synchronization: Physical and logical clocks. • Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms. • Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and	12

		resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.	
3	Distributed Fault Handling	- Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem. - Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery. - Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocols.	10
4	Real Time Operating Systems	- Types of Real time tasks, Timing Constraints, Modeling Timing Constraints. - Task Scheduling: Types of tasks and their characteristics, Task Scheduling, Clock driven Scheduling , Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm - Resource Handling: Resource Sharing, Priority Inversion, PIP,PCP,HLP. - Scheduling real time tasks in distributed systems	12
5	Database Operating systems	- Concurrency control : Database systems, Concurrency control model of database systems, Problem of Concurrency Control, serializability theory, Distributed Database Systems - Concurrency Control Algorithms : Basic synchronization Algorithms, Lock based, Timestamp based and Optimistic Algorithms, Concurrency Control Algorithms : Data Replication	06
6	Case Study	- DOS: Mach, Amoeba - .RTOS : UNIX as RTOS , Windows as RTOS. - Mobile OS. - Cloud OS	04

Text books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems" .MC Graw Hill education.
2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson education.

Reference Books:

1. Andrew S.Tanenbaum, "Modern Systems Principles and Paradigms". PHI.
2. Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
3. Andrew S.Tanenbaum, "Distributed Operating System", Pearson Education.
4. Jane W. S. Liu, “Real Time Systems”, Pearson education.

The suggested lists of experiment/case study of Advanced Operating System are as follows:

I. Flexibility/Load Distribution

1) Implement and study the incremental/decremented growth of response and service times for different number of client and servers for servicing continuous stream(s) of constant sized messages.
2) Implement a name server for registration and identification of services running on another server. The client contacts the name server for a particular service and the service request is forwarded to the specific server registered on the name server. Study the load distribution for different number of service servers, clients and service requests.

II. Fault Tolerance/Reliability

1) Implement a fault tolerant client and server application using the concept of name server. The client incorporates fault tolerant by sending a service request to another server using name server, if the current server fails to respond within 10 seconds.
2) Implement a stateful server for a transaction consisting of mainly four operations viz. open a file, close opened file, read from opened file and write to opened file. The state of file operation is maintained at stateful server.

III. Performance

1) Implement a client-server application for a computing problem (of exponential complexity). Compare the performance for a local and remote machine of different speeds.
2) Implement parallel Fast-Fourier-Transform (parallel FFT). Show that the overall communication time complexity is O ((n/p) log p), and the computational complexity of the parallel algorithm is O (n log n/p) where n is number of elements, and p is number of processes.

IV. Transparency

1) Implement a client-server application to show transparent service access so that the client does not know the location of service is being executed.

V. Mobile Application

1) Implement a client-server application to allow transfer of any data (e.g. images, documents, videos etc.) on android mobile operating system. Each mobile device runs a program which acts as a server when it receives data from another device or a client when it sends data to another mobile device.
2) Implement a distributed share list among a group of mobile device users which is similar to Google document.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1011	**Logic & Automated Reasoning**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Represent mathematical and other knowledge using logical formalism.
2. Understand theoretical concepts and results that form the basis of current automated reasoning systems.
3. Understand advanced techniques of resolution theorem proving and be able to use them.

Outcomes: Learner will be able to ...

- Comprehend syntax and semantics of Propositional logic, first-order logic, inference system, proof, soundness and completeness.
- Apply various deductive algorithms and models for reasoning
- Emphasize various techniques for automated reasoning, theorem proving

Sr. No.	Module	Detailed Contents	Hours
1	Introduction to Logic	• Mathematical Logic, Propositional Logic, First-Order Logic, Modal Logic, Temporal Logic, • Program Verification	04
2	Propositional Logic	• Formulas, Models, Tableaux: Propositional Formulas, Interpretations ,Logical Equivalence, Sets of Boolean Operators, Satisfiability, Validity and Consequence, Semantic Tableaux, Soundness and Completeness • Resolutions: Conjunctive Normal Form, Clausal Form, Resolution Rule, Soundness and Completeness of Resolution • Binary Decision Diagrams: Motivation Through Truth Tables, Definition of Binary Decision Diagrams, Reduced Binary Decision Diagrams	12
3	First-Order Logic	• Formulas, Models, Tableaux: Relations and Predicates, Formulas in First-Order Logic, Interpretations, Logical Equivalence, Semantic Tableaux, Soundness and Completion of Semantic Tableaux • Resolution: Ground Resolution, Substitution, Unification, General Resolution, Soundness and	12

		Completeness of General Resolution • Introduction to Logic Programming: Prolog	
4	Reasoning Methods	• SAT Solvers: Properties of Clausal Form, • Davis-Putnam Algorithm, DPLL Algorithm • Deductive Systems: Gentzen System, Hilbert System • Terms and Normal Forms : First-Order Logic with Functions, PCNF and Clausal Form, Herbrand Models	08
5	Automated Reasoning	• Automated Reasoning for Web system, • Semantic Web applications, • REWERSE-automated reasoning method and tools,	06
6	Theorem Proving	• Some exposure to theorem proving systems such as Prolog, PVS, SPIN	06

Text Books

1. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer
2 Arindama Singh, Logics for Computer Science, Prentice Hall of India.

Reference Books

1. Handbook of Practical Logic and Automated Reasoning, John Harrison, Cambridge University Press
2. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Note: One Case Study to be given for Module 5 and 6 based on the above concepts.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSDLO1012</td><td rowspan="6">Image Analysis and Interpretation</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td rowspan="3">Pract</td><td rowspan="3">Oral</td></tr>
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<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Objective:

1. To explore the various Image Analysis and Interpretation techniques
2. To become accustomed with different methods of Feature generation, Representation Description and Interpretation.
3. To Analyze & Interpret Images and use for various applications

Outcome: Learner will able to

- Understand the importance of Image Analysis and Interpretation.
- Analyze various methods of Image Analysis
- Use the methods of image analysis and interpretation for various Image Processing applications.

Prerequisite: Image Processing, Mathematics**.**

Sr. No.	**Module**	**Detailed content**	**Hours**
1	Introduction to Image Processing System	• Introduction, • Sources of Images • Classification of Images • Elements of Image Processing System • Image Modelling – Sampling, Quantization and Representing Digital Images. • Image Preprocessing – ○ Enhancement : Power Law Transformation, Contrast Stretching and Histogram Equalization ○ Spatial domain Filters: Smoothing, Sharpening	08

2	Feature Generation	• Introduction • Basis Vectors and Images • K-L transformation • Singular Value Decomposition • Independent Component Analysis • Non–Negative Matrix Factorization • Non- linear Dimension Reduction • Haar Transform • Multi resolution Interpretation	12
3	Image Analysis	• Data Structure for Image Analysis o Levels of image data representation o Traditional image data structures o Hierarchical data structures • Image Segmentation o Thresholding o Edge based and Region Based Segmentation o Boundary Extraction • Feature Extraction o Spatial Feature Extraction o Transform Feature Extraction	10
4	Image Representation and Description	• Boundary Representation • Region Representation • Moments Representation • Structure Representation • Shape Representation • Texture Representation	06 .
5	Statistical decision making and Vector Quantization	• Statistical decision making: Bayesian theorem Multiple features Conditionally independent features Decision boundaries Unequal cost of error Estimation of error rates • Vector Quantization	08
6	Applications	Case Study on • Remote Sensing Images • Medical Images • Image Forensics: Finger print classification • Digital Watermarking for Images	04

Text Books:

1. Fundamentals of Digital Image Processing Anil K. Jain, PHI
2. Pattern Recognition, Theodoridis & Koutroumbas, 4th Edition, Academic Press
3. Digital Image Processing ,Second Edition, Rafael C. Gonzalez and Richard E.Woods, Pearson Prentice Hall,
4. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar,Tata McGraw-Hill Education Private Limited, 2011.
5. Digital Image Processing, S. Sridhar, Oxford University Press.
6. Image Processing, Analysis, and Machine Vision, Milan Sonka Vaclav Hlavac Roger Boyle.
7. Pattern recognition and Image analysis by Earl Gose, Richard Johnsonbaugh, Steve Jost, PHI publication

Reference Books:

1. Digital Image Processing An Algorithm Approach, Madhuri A. Joshi, PHI
2. Principles of Soft Computing , S N Shivanandan, S N Deepa, Wiley

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td rowspan="6">CSDLO1013</td><td rowspan="6">Natural Language Processing</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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</table>

Course Objectives:

1. To formulate the problems and solutions of NLP and establish their relation to linguistics and statistics.
2. To implement various language Models.
3. To design systems that uses NLP techniques
4. To train and evaluate empirical NLP systems.

Course Outcomes: At the end of the course student should be able to

- Model linguistic phenomena with formal grammars.
- Design, implement, and analyze NLP algorithms
- Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction...etc.
- Implement proper experimental methodology for training and evaluating empirical NLP systems.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP- Machine translation, question answering system, Information retrieval, Text categorization , text summarization & Sentiment Analysis	3
2	**Word Level Analysis**	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology; Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST -Porter stemmer. N –Grams- N-gram language model , N-gram for spelling correction .	9

3	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, class based n –grams .Context Free Grammar – Constituency , Context free rules & trees, Sentence level construction , Noun Phrase, coordination, agreement, the verb phrase & sub categorization	10
4	**Semantic Analysis**	Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Wordnet, Selectional restriction based disambiguation & limitations , Robust WSD – machine learning approach and dictionary based approach	10
5	**Pragmatics**	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference, preferences in pronoun interpretation , algorithm for pronoun resolution .Text coherence, discourse structure	8
6	**Applications** **(preferably for Indian regional languages)**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis.	8

Text Books:

1. Daniel Jurafsky, James H. Martin “Speech and Language Processing” Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, “ Foundations of Statistical Natural Language Processing “, MIT Press, 1999.

Reference Books :

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni “ Multilingual natural language processing applications” Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) “ The Handbook of Computational Linguistics and Natural Language Processing “ ISBN: 978-1-118-

Case study/Experiments:

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: **http://cse24-iiith.virtual-labs.ac.in/#**

Sample Case study/Experiments:

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Word Analysis
2. Word generation
3. Stop word removal
4. Stemming
5. Morphology
6. POS Tagging
7. Chunking
8. N-gram language model

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td rowspan="6">CSDLO1014</td><td rowspan="6">Computational Intelligence</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
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</table>

Course Objectives:

1. To explore the various computational Intelligence techniques
2. To become familiarized with Neural Network, Fuzzy logic & evolutionary techniques
3. To learn to apply computational Intelligence to different applications

Course Outcomes: Learner will able to

- Understand the importance of computational Intelligence.
- Analyze various computational Intelligence technology
- Design and implement various intelligent system.

Prerequisite: Soft Computing, Mathematics

Sr. No.	**Module**	**Detailed content**	**Hours**
1	Introduction to Computational Intelligence paradigms	Artificial Neural Networks, Fuzzy Systems, Genetic Algorithms, Swarm Intelligence, Artificial Immune System, Applications	6
2	Artificial Neural Networks & SVM	Basic models of ANN: NN Architecture, MP Neuron, Linear separability, activation functions, types of learning Learning Rules: Hebbian, Perceptron, Delta, Winner-take all Supervised NN: Perceptron Network: SDPTA, SCPTA, MCPTA, Adaline networks Support Vector Machine: Binary SVM	14
3	Fuzzy Systems	Fuzzy Sets: Definition, operations, properties, relations, characteristics, membership functions, defuzzification.	8
4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples.	10

		Swarm Intelligence: Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social-Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO, Ant Algorithm: Simple Ant Colony Optimization	
5	Artificial Immune System	Natural Immune System: Classical view, Antibodies and antigens, Artificial Immune Models: Artificial Immune system algorithm, classical view models, CLONALG	4
6	Applications	Character Recognition, Genetics Algorithm in game playing, Color Recipe prediction- Single MLP approach ANT algorithm/Swarm Intelligence – TSP, Best path finding	6

Text Books:

1. Computational Intelligence An Introduction, Andries P. Engelbrecht, Wiley, 2nd Edition
2. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Wiley, 2nd edition
3. Introduction to Artificial Neural Systems, Jacek M. Zurada, West Publication
4. Pattern Recognition, Theodoridis and Koutroumbas , 4th Edition, Academic Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1015	**User Experience Design**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To study and understand importance of user experience design principles
2. To understand elements of user experience design
3. To encourage students to participate in designing futuristic applications

Course Outcomes: Learner will be able to:

- To Apply principles of user experience
- To apply emerging and established technologies to enhance User Experience design
- To create interface for international standards with ethics
- To evaluate user experience.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc. User experience design is concerned with all the elements that together make up user interface, including layout, visual design, text, brand, sound, and interaction. User Experience Design works to coordinate these elements to allow for the best possible interaction by users.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction	Introduction to interface design, Understanding and conceptualizing Interface, Understandinguser's conceptual cognition.	04
2	Elements of UX Design	Core Elements of User Experience, Working of UX elements	04
3	The UX Design Process – Understanding Users	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.	08
4	The UX Design Process- The Structure: Information Architecture and Interaction Design	Visual Design Principles ,Information Design and Data Visualization Interaction Design ,Information Architecture , Wire framing & Storyboarding,UI Elements and Widgets, Screen Design and Layouts	08

5	UX Design Process: Prototype and Test	Testing your Design, Usability Testing,Types of Usability Testing ,Usability Testing Process, Preparing and planning for the Usability Tests, Prototype your Design to Test, Introduction of prototyping tools,conducting Usability Test, communicating Usability Test Results	08
6	UX Design Process: Iterate/ Improve and Deliver	Understanding the Usability Test,findings, Applying the Usability Test, feedback in improving the design. Communication with implementation team. UX Deliverables to be given to implementation team	04

Text Books

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin
3. Designing The user Interface by Shneiderman, Plaisant,Cohen,Jacobs Pearson

Reference Books:

1. The Elements of User Experience by Jesse James Garrett
2. Don’t make me think, by Steve Krug
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credits
ILO 1011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system,	05

	financial justification of PDM, barriers to PDM implementation	
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only Four question need to be solved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 1012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 1013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 1014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE).
2. To list the guidelines for designing experiments.
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, “Taguchi Technique for Quality Engineering,” McGraw Hill.
7. Madhav S Phadake, “Quality Engineering using Robust Design,” Prentice Hall.

Course Code	Course Name	Credits
ILO 1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO 1016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 1017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06

04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

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4. Only Four question need to be solved.

REFERENCES:

1. ‘Disaster Management’ by Harsh K.Gupta, Universities Press Publications.
2. ‘Disaster Management: An Appraisal of Institutional Mechanisms in India’ by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. ‘Introduction to International Disaster Management’ by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. ‘Disaster Management Handbook’ by Jack Pinkowski, CRC Press Taylor and Francis group.
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 1018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction	10

	motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
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End Semester Theory Examination:
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4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com ; www.bee-india.nic.in

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<tr><td rowspan="6">CSL101</td><td rowspan="6">Computational Laboratory-I</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
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</table>

Module	**Detailed Content**	**Lab Session**
Algorithm and Complexity	• Implementation of algorithms which demonstrate greedy strategy, dynamic programming, Flow network, parallel algorithm and string matching (any two).	02
Networking Design	• Install tool CISCO Packet Tracer Student Edition (open-source). Explore this tool and use it to design an Internetwork using switches, routers and the concept of VLAN. Configure different routing protocols like RIP, OSPF, EIGRP etc. on the network you have designed and observe the performance. Test your network using "ping" and "show ip route". • Install mininet (open-source). Create virtual architecture for SDN openvswitch(s), host(s), controllers(s) and test various topologies using basic commands like ping. Optionally connect mininet openvswitch with external controllers like open day light (open-source).	05
Advanced Operating System	• The Advanced Operating System laboratory work should clarify the basic concepts of **Flexibility / Load Distribution** (system scales easily to accommodate increase in number of machines with corresponding increase in performance), **performance** (running an application should not be appreciably worse than running it on a single CPU system), **reliability** (system should be available and functional in presence of failures) and **transparency** (system should provide a single system image). • Every student should perform at least two experiments from above categories (i.e. Flexibility/Load Distribution, Fault Tolerance/Reliability, Performance, Transparency and Mobile Application) using C / C++ programming language.	05

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

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Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC201	**High Performance Computing**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms

Course Outcomes: Learner will be able to:

- Understand different parallel processing approaches and platforms involved in achieving High Performance Computing.
- Understand design Issues and limitations in Parallel Computing.
- Learn to programming using message passing paradigm using open source APIs, design algorithms suited for Multicore processor and GPU systems using OpenCL, OpenMP.
- Analyze and optimize performance parameters.
- Understand HPC enabled Advanced Technologies.

Sr.No	**Module**	**Detailed Content**	**Hours**
1	Parallel Processing approaches	**Introduction to Parallel Processing:** Levels of Parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation etc.). Loosely coupled and Tightly coupled **HPC Platforms:** Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, hybrid (MPI/OpenMP) programs, Grid Computing, Cloud Computing , Multi-Core Processors, accelerators, GPGPUs	06
2	Design Issues and limitations in Parallel Computing	Parallel Architecture, (Interconnection network, processor Array, Multiprocessor) Designing Parallel algorithms (Partitioning, Communication, Mapping, Matrix input/output)	10

		Issues: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures **Limitations:** Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	
3	Programming using message passing paradigm	Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing	10
4	Parallel Programming using GPGPU	An Overview of GPGPUs, An Overview of GPGPU Programming, An Overview of GPGPU Memory Hierarchy Features, Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL	12
5	Performance Measures	Performance measures: Speedup, efficiency and scalability. Abstract performance metrics (work, critical paths), Amdahl`s Law, Gustavson's law, weak vs. strong scaling, performance bottlenecks, data races and determinism, data race avoidance (immutability, futures, accumulators, dataflow), deadlock avoidance, abstract vs. real performance (granularity, scalability)	06
6	HPC enabled Advanced Technologies	Nanotechnology and its impact on high performance computing, Power aware processing techniques in high performance computing. Case studies on high performance computing	04

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang,Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill,Second Edition, 2010.

3. Edward Kandrot and Jason Sanders, “CUDA by Example – An Introduction to General Purpose GPU Programming”,Addison-Wesley Professional ©, 2010.
4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, “Heterogeneous Computing with OpenCL”, Elsevier, Second Edition, 2013.

Reference Books:

1. Georg Hager, Gerhard Wellein, “Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
2. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill International Editions, Computer Science Series, 2008.
3. Kai Hwang, Zhiwei Xu,“Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw Hill, 1998.
4. Laurence T. Yang, MinyiGuo, “High- Performance Computing: Paradigm and Infrastructure” Wiley, 2006.

List of Experiments to be included in Computational Lab II

Solve given problems using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.

1. Matrix-Matrix multiplication – simple/Cannon’s/ DNS algorithm
2. Sorting – Bitonic/Shell sort/Quicksort/Bucket/ Radix
3. All-pairs shortest paths – Dijkstra’s algorithm/Floyd’s algorithm

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
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<tr><td rowspan="6">CSC202</td><td rowspan="6">Data Science</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Course Objectives:

1. To understand the foundations of the Data Science process, methods and techniques
2. To represent and organise knowledge about large heterogeneous data collections
3. To use mathematical models and tools for large-scale data analysis and reasoning
4. To work and evaluate Data at Scale – Working with Big Data

Course Outcome: Learner will able

- Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
- Apply statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.
- Design, implement, and evaluate the core algorithms underlying an end-to-end data science workflow, analysis, and visualization of information derived from large datasets.
- Apply “best practices" in data science with modern tools

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Data Science	Data science process: Defining goal, retrieving data, preprocessing data, exploratory data analysis, model building and data visualization, Ethical issues in data science. Probability: review of probability theory, normal distribution, Gaussian discriminant analysis: Linear discriminant analysis (LDA), Logistic regression: Bayesian logistic regression,	08
2	Predictive and Descriptive Models	Descriptive Modeling: Principal components analysis (PCA), singular value decomposition (SVD), probabilistic PCA, applying PCA to new data, PCA for data interpretation., EM algorithm for PCA, Independent Component Analysis (ICA), Maximum likelihood estimation using EM. Predictive Modeling: Predictive modeling process,	12

		supervised and unsupervised learning, parametric and non-parametric models, business intelligence, challenges in using predictive analytics Introduction to time series analysis and time series mining, Introduction to spatio-temporal data, spatio-temporal model, fast dynamic time warping.	
3	Evaluation and Methodology of Data Science	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression Interpretation of results: Confidence interval for accuracy, hypothesis tests for comparing models, algorithms.	03
4	Text Analytics and Recommendation system (RS)	Introducing text mining, text mining techniques, Understanding Text Mining Process, Sentiment Analysis. Introduction to RS, content based RS, collaborative RS, hybrid RS. Issues and challenges RS, examples of real word RS, e.g., Amazon, mobile RS, etc.	08
5	Data Communication and Information Visualization	Data Communication: cost Function, how to Minimize cost function, coefficients of determination. Information visualization: effective information visualization, visual Encodings, perception of visual cues, data scales, visualizing time series data, data journalism, dashboards.	08
6	Scaling with Big Data	Introduction of big data, characteristics of big data, data in the warehouse and data in Hadoop, Importance of Big data, Big data Use cases: patterns for Big data deployment, MapReduce and Hadoop Ecosystem architecture, NoSQL,analyzing data with Pig and R.Sharding, indexing large-scale data, sampling, data leakage, data incest.	09

Reference Books:

1. Davy Cielen,Meysman,Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Paul C. Zikopoulos, Chris Eaton, Dirk deRoos, Thomas Deutsch and George Lapis, “Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data”, The McGraw Hill Companies, 2012

4. Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
5. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
6. Seema Acharya and SubhashiniChellappan, “Big Data and Analytics”, Wiley
7. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
8. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
9. EMC Education Services,”Data Science and Big Data Analytics”,Wiley
10. DT Editorial Services, “Big Data Black Book”, Dreamtech Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSC203</td><td rowspan="6">Ethical Hacking and Digital Forensics</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
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<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Course Objectives:

1. To understand underlying principles and many of the techniques associated with the digital forensic practices.
2. To explore practical knowledge about ethical hacking Methodology.
3. To develop an excellent understanding of current cyber security issues and ways that user, administrator and programmer errors can lead to exploitable in securities.

Course Outcomes: Learner will able to

- Understand the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
- Acquire knowledge of various digital forensic tools and ethical hacking.
- Interpret security issues in ICT world, and apply digital forensic tools for security and investigations.
- Achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system, mobile, email etc.
- Generate legal evidences and supporting investigation reports.

Sr. No.	**Module**	**Detailed content**	**Hours**
1	Ethical Hacking Methodology	Introduction, Steps of Ethical Hacking: Planning, Reconnaissance, Scanning, Exploitation, post exploitation and result reporting. Ethical Hacking Tool: Metasploit	6Hrs
2	Introduction to Digital Forensics	The Need for Digital Forensics, Types of Digital Forensics, Introduction to Incident Response Methodology, Incident handling steps, Ethics in Digital Forensics.	6 Hrs
3	Data Collection	Live Data Collection from Windows and Unix Systems, Tools for Forensic Duplication, Collecting Network-based Evidence, Evidence Handling - Chain of Custody. Data Collection Forensic Tools : Forensics Toolkit/ WinHex	14 Hrs
4	Data Analysis	Data Analysis, Investigating Windows, Unix Systems, Analysing Network Traffic, Investigating Routers, Email forensics	12 Hrs

		Data Analysis Tools : Nmap/Wireshark/Helix3pro	
5	Mobile Device Forensics	Crime and mobile phones, evidences, forensic procedures, files present in SIM cards, device data, external memory dump, and evidences in memory card, operator's networks.	6 Hrs
6	Forensic Investigation Reporting	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	4 Hrs

Text Books:

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing, Second Edition: Ethical Hacking and Penetration Testing Made Easy", 2nd Edition, Syngress.
3. Investigation Procedures and Response**,** EC-Council Press.

Reference Books:

1. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999.
2. Debra Littlejohn Shinder and Ed Tittel, "Scene of the Cybercrime: Computer Forensics Handbook", Syngress Publishing, Inc.
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools andTechnology", Academic Press, 1st Edition, 2001
4. Nina Godbole, "Information Systems Security", Wiley India, New Delhi
5. William Stallings, "Cryptography and Network Security", Pearson Publication

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2021	**Data Storage and Retrieval**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Understand need of storage network with its architecture, features, components, topology, benefits and limitations.
2. Study the impact of downtime in terms of losses and business continuity.
3. Understand the basic terminologies and components in information retrieval systems.
4. Compare and contrast Information Retrieval models.

Course Outcomes: Learner will able to…

- Evaluate storage architecture, ISS, SAN, NAS and IP SAN.
- Design the storage infrastructure for business continuity.
- Implement and evaluate various Information Retrieval Models.

Sr. No.	Modules	Detailed content	Hours
1	Introduction to Data Storage	Need for storage network, Evolution of storage technology and architecture, Key Challenges in managing information, Information lifecycle, Disk drive performance, Fundamental laws governing disk performance.	04
2	Storage System Environment	Basic Software for Storage Networking: Software for SANs, Shared access data managers, Volumes(RAID): Resilience, performance and flexibility, File systems and application performance. Intelligent Storage System:Storage Virtualization: Form of Virtualization, storage virtualization configurations and challenges, Types of storage virtualization. Content-Addressed Storage: Architecture, Object storage and Retrieval in CAS.	08
3	Storage Networking	Storage Area Networks: Fibre Channel, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel	12

	Technologies	Architecture, Zoning, Fibre Channel Login Types, FC Topologies. Network-Attached Storage: General-Purpose Servers vs. NAS Devices, Benefits of NAS, NAS File I/O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. IP SAN: iSCSI, FCIP.	
4	Business Continuity and Enterprise backup	Introduction to Business Continuity: Information availability, BC planning lifecycle, Failure Analysis, Business impact analysis. Enterprise backup software for SAN: Backup management, Enterprise data protection, Backup architecture, Backup policies, Minimizing impact of backup, Lan-free and serverless backup.	06
5	Information Retrieval	Introduction to Information Retrieval(IR), Objectives and Components of IR system, Taxonomy of IR models, Information Retrieval process, Documents and Query forms	06
6	Retrieval Models	Query structure, The matching process, Text analysis	10

Text Books:

1. G. Somasundaram, Alok Shrivastava, "Information Storage and Management", EMC Education services", Wiley Publication, Edition 2009
2. Richard Barker, Paul Massiglia, "Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs", Wiley India
3. Robert R. Korfhage, "Information Storage and Retrieval", Wiley Publication

Reference Books:

1. Ulf Troppens,Wolfgang Muller-Friedt,Rainer Wolafka, "Storage Networks Explained" Wiley Publication
2. Spalding, Robert. Storage Networks: The Complete Reference. Tata McGraw-Hill Education, 2003

3. Manning, Christopher D., Prabhakar Raghavan, and Hinrich Schütze. Introduction to information retrieval. Vol. 1, no. 1. Cambridge: Cambridge university press, 2008.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2022	**Internet of Things**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Provide an overview of concepts, main trends and challenges of Internet of Things.
2. Develop the ability to use Internet of Things related software and hardware technologies.
3. Provide the knowledge of data management business processes and analytics of IoT.
4. Develop skills to relate the IoT technologies for practical IoT applications such as smart objects.

Course Outcomes: Learner will able to -

- Explain and interpret the Internet of Things concepts and challenges.
- Experiment with the software and hardware IoT Technologies.
- Understand data management and business processes and analytics of IoT
- Design and develop small IoT applications to create smart objects

Sr. No.	**Module**	**Detailed Content**	**Hours**
1	Introduction to Internet of Things	IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects.	8
2	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Interfacing.	8
3	IoT Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others.	8

4	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT.	4
5	Data Management, Business Process and Analytics	Data Management, Business Process in IoT, IoT Analytics, Creative Thinking Techniques, Modification, Combination Scenarios, Decentralized and Interoperable Approaches, Object – Information Distribution Architecture, Object Naming Service (ONS), Service Oriented Architecture, Network of Information, Etc.	12
6	Application and Use Cases	Concrete Applications and Use – Cases of Web Enabled Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. M2M, Industrial IoT Applications.	8

Text Books:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi ,Wiley .
3. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

1. The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.
2. IoT –From Research and Innovation to Market development, River Publication by Ovidiu Vermesan and Peter Friess.
3. Building Internet of Things with Arduino by Charalampos Doukas.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2023	**Advanced Soft Computing**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

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Course Objectives:
1. To familiarize various soft computing techniques.
2. To relate various soft computing techniques in practical scenario.
3. To understand hybrid approach for application development.

Course Outcomes: At the end of the course, the learner will be able to-
- To demonstrate various soft computing techniques.
- To apply and analyze different soft computing techniques for solving practical applications.
- To design an intelligent system for social and technical problems.

Pre-requisite: Basic mathematics, soft computing, Computational intelligence

Sr. No.	Module	Detailed content	Hours
1	Introduction	Differentiate Hard and Soft Computing, Soft Computing Constituents, Neuro Fuzzy and Soft Computing Characteristics	2
2	Fuzzy Logic & Rough Set Theory	Fuzzy Relations and Fuzzy Rules, Generalized Modens Ponens, Defuzzification and its Types Fuzzy Inference Systems, Design of Fuzzy Controller, Introduction to Rough Sets	12
3	Supervised Network	Error Back Propagation Training Algorithm, Radial Basis Function	10
4	Unsupervised Network	Kohenon Self Organizing Maps, Basic Learning Vector Quantization, Basic Adaptive Resonance Theory	12

5	Hybrid Systems and Introduction to Deep Learning	Fuzzy-Neural Systems, Neuro-Genetic Systems Fuzzy-Genetic Systems, Deep Learning : Definition & background, historical context of deep learning, Three classes of deep learning network.	8
6	Applications and Case Study	Automobile Fuel Efficiency using ANFIS Color Receipe prediction using CANFIS	4

Text Books

1. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
2. S. Rajasekaran and G.A. Vijaylakshmi Pai.. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
4. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
5. Samir Roy, Udit Chakraborty "Introduction to Soft Computing" Pearson Education India.
6. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.
7. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.

Reference Books:

1. Fakhreddine O. Karry, Clarence De Silva," Soft Computing and Intelligent systems Design Theory, Tools and Applications" Pearson 2009.
2. Li Deng and Dong Yu , 'Deep Learning Methods and Applications'.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2024	**Semantic Web & Social Network Analysis**	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Semantic Web provide a graph model (RDF), a query language (SPARQL) and schema definition frameworks(RDFS and OWL) to represent and exchange knowledge online. These technologies provide a whole new way of capturing social networks in much richer structures. Social network Analysis(SNA) tries to understand and exploit the key features of social networks in order to manage their life cycle and predict their evolution. Objective of the course is to understand how to facilitate and enhance the analysis of online social networks, exploiting the power of semantic web technologies.

Course Objectives (CEO):

1. To understand the basics of Semantic Web Technologies
2. To Learn knowledge representation for Semantic Web
3. To understand the importance of Social Network Analysis
4. To understand and use semantic web technologies for social network analysis

Course Outcomes: At the end of the course, the students will be able to :

- Understand the Semantic Web and Social Networks
- Understand Electronic sources for network analysis and different ontology languages.
- Model and aggregate social network data.
- Design and Analyze social network using semantic web technologies.

Pre-requisites: Web Technologies; Data Structures, Databases, Logic-First order logic, knowledge representation, Data Mining ,Distributed Systems.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction Semantic Web and Social Networks: .	The Semantic Web- Limitations of the current Web, The semantic Web Technologies ,A Layered Approach, The emergence of the social web. Social Network Analysis- What is network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis	**04**
2	Semantics and Knowledge Representation on the Semantic Web	Electronic sources for network analysis- Electronic discussion networks, Blogs and online communities Structured Web Documents-XML, Describing web Resources-RDF, RDFSchema, Querying Knowledge Representation on the Semantic Web-SPARQL	**10**

3	Modeling and aggregating social network data:	Ontologies and their role in the Semantic Web, Ontology languages for the Semantic Web-RDFS, OWL. State-of-the-art in network data representation, Ontology Engineering, Semantic Web Knowledge Management Architecture ,Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data.	**10**
4	Developing social-semantic applications:	Building Semantic Web applications with social network features, Flink: the social networks of the Semantic Web community, open academia: distributed, semantic-based publication management	**08**
5	Extracting and Mining Communities in social network and social network analysis-	Extracting evolution of Web Community from series of web archive – Detecting communities in social networks-Definition of community – Evaluating communities – methods for community detection and mining – Semantic based social network analysis.	**08**
6	Applications of community mining algorithms , Visualization-	Applications of community mining algorithms-Influence and Homophily, Recommendation, Behavior Analytics, Visualization- Graph theory – Centrality – Clustering- Node Edge Diagrams –Matrix Representation –,Benefits of semantic social networks for communities	**08**

Text Books:

1. Grigoris Antoniou and Frank van Harmelen "Semantic Web Primer"second edition
2. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
3. Reza Zafarani,Mohammad Ali Abbasi,Huan Liu "Social Media Mining: Introduction",Cambridge University press.

Reference Books:

1. Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking Techniques and applications", First Edition Springer, 2011.
2. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Retrieval and Access: Techniques for Improved user Modelling",IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009.
5. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011.

6. Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.
7. Toby Segaran,colin Evans and Jamie Taylor “Programming Semantic Web”, O’Reilly.
8. Berners Lee, Godel and Turing “Thinking on the Web “,Wiley inter science, 2008.
9. Vladimir Geroimenko, Chaomei Chen “Visualizing the Semantic Web”, Springer 2006.

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Theory Examination:

1. Question paper will comprise of total six question
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4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSDLO2025</td><td rowspan="6">Information and Communication Technologies (ICT) for Social Cause</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
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<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Course Objectives:

1. To understand use of ICT techniques in various applications.
2. To Recognize, Represent and Design the ICT systems for social cause.

Outcome: Learner will able

- To understand technologies used in ICT.
- To design and implement ICT application for societal benefits
- To demonstrate use of emerging technology for social applications.

Sr. No.	Module	Detailed content	Hours
1	Basics of ICT	▪ Introduction to ICT ▪ Challenges and opportunities in using technology for a social cause. ▪ Understanding the social and cultural influences that affect users. ▪ Creating an ICT – handling text, data and media	4
2	Communication Techniques in ICT	▪ Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth ▪ Satellite Techniques – architecture AND working principles GPS/GPRS ▪ Cloud computing – Introduction, cloud services, Cloud service providers, ▪ GIS– Working principle and architecture for ICT	12
3	Data acquisition in ICT	• Recognition systems RFID,OMR • Data acquisition process for MEMS devices • Sensors – Programming, communication with cloud. • Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc	8
4	Data Management in ICT	▪ Data management ▪ Data storage structures	8

5	knowledge management in ICT	▪ Knowledge elicitation ▪ Knowledge Engineering Methodology ▪ Knowledge representation and visualization techniquesAutomatic discovery programs ▪ Data visualization ▪ Auditing knowledge management ▪ Linking knowledge management to business performance	8
6	ICT applications and Social Audit	• Study of ICT applications in various domains such as Agriculture, Healthcare, Education, SCM, Finance, Law. • Social Audit: The Social Audit Tool (SAT), Social Auditing, Characteristics of the SAT, Uses of the SAT , Benefits of the SAT, The SAT Methodology , Purposes, Method, and Approach of the SAT, Implementing the SAT, The Social Auditor	10

References Books:

1. ICT Futures :Delivering Pervasive Realtime And Secure Services Edited By Paul Warren, Jhon Davies, David Brown , Wiley Publication
2. Jochen Schiller, "Mobile communications", Addison wisely, Pearson Education.
3. GIS Fundamentals, Applications and Implementation, Dr.K.Elangovan, New India Publications.
4. Cloud Computing : A practical Approach: By Anthony T. Velte : Tata McGraw-Hill
5. An Introduction to Microelectromechanical systems Engineering, NadimMaluf , Artech House.
6. Knowledge management business intelligence , and content management : The IT practitioner’s Guide by Jessica Keyes
7. ICTs for transfer of technology tools and techniques , S.R. Verma , New India
8. USAID, Social Audit Tool Handbook, Using the Social Audit to Assess the Social Performance of Microfinance Institutions,2008.

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credits
ILO 2021	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.	8

	Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO 2022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs;	10

	Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:

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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
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4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	**Enterpreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

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End Semester Theory Examination:
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4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7

03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis	**08**

	i. Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
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2. All question carry equal marks
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4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
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4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
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9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 2028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition	04

	(Process of Digital Transformation)	
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
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4. Only Four question need to be solved.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO2029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Pract</th><th>Tut</th><th>Theory</th><th>Pract</th><th>Tut</th><th>Total</th></tr>
<tr><td rowspan="6">CSL201</td><td rowspan="6">Computational Laboratory II</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td colspan="2" rowspan="3">Pract / Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>---</td><td>---</td><td>---</td><td>---</td><td>25</td><td colspan="2">25</td></tr>
</table>

Module	**Detailed Content**	**Lab Session**
High Performance Computing	Implement any two parallel algorithms(e.g. sorting, matrix- matrix multiplication) using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.	04
Data Science	Exploratory data analysis using Map Reduce , NoSQL, R, python and Hadoop Ecosystem Predictive data Analytics using open source tools like Rstudio, RWeka, RHadoop	04
Ethical Hacking and Digital Forensics	Operating System Forensics, Email Forensics and Mobile Forensics using open source forensics tools (e.g., Helix3pro, WinHex)	04

Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

<table>
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<tr><td rowspan="6">CSL202</td><td rowspan="6">DEC Laboratory-II</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
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</table>

Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS301	**Special Topic Seminar**	----	06	--	---	03	--	03
ME-CS302	**Dissertation-I**	---	24	--	---	12	--	12
Total		----	**30**	--	---	**15**	--	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ME-CS301	**Special Topic Seminar**	---	---	---	---	---	50	50	100
ME-CS302	**Dissertation-I**	---	---	---	----	---	100	---	100
Total		---	---	---	----	---	**150**	**50**	**200**

Guidelines Special Topic Seminar:

- Seminar should be based on thrust areas in Computer Engineering/ Information Technology.
- Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
- Students should use multiple literatures (at least 10 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Implementation of one paper from refereed journal as a case study.
- Compile the report in standard format and present infront of Panel of Examiners. (Pair of Internal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputed International / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS401	**Dissertation-II**	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**13**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
ME-CS401	**Dissertation-II**	--	---	---	---	---	100	100	200
Total		**--**	**---**	**---**	**---**	**---**	**100**	**100**	**200**

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.

AC- 6.6.2012
Item No.4.63

UNIVERSITY OF MUMBAI

Revised Syllabus for the

M. E. (Electronics Engineering):

Program : M.E.

Course: Electronics Engineering

(As per Credit Based Semester and Grading System with
effect from the academic year 2012–2013)

Program Structure for Master of Engineering-Electronics Engineering

(With Effect From 2012-2013)

Semester I

Subject Code	Subject Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ExC101	System Modeling and simulation	04	--	--	04	--	--	04
ExC102	Modelling of Microelectronic Devices	04	--	--	04	--	--	04
ExC103	Embedded system	04	--	--	04	--	--	04
ExE101X	Elective I	04	--	--	04	--	--	04
ExE102X	Elective II	04	--	--	04	--	--	04
ExL101	Laboratory I	--	02	--	--	01	--	01
ExL102	Laboratory II -	--	02	--	--	01	--	01

Total	**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	**Subject Name**	**Examination Scheme Sem-I**							
		Theory					**Term Work**	**Pract. /oral**	**Total**
		Internal Assessment			**End Sem.Exam.**	**Exam. Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					
ExC101	System Modeling and simulation	20	20	20	80	03	--	--	100
ExC102	Modelling of Microelectronic Devices	20	20	20	80	03	--	--	100
ExC103	Embedded system	20	20	20	80	03	--	--	100
ExE101X	Elective I	20	20	20	80	03	--	--	100
ExE102X	Elective II	20	20	20	80	03	--	--	100
ExL101	Laboratory I	--	--	--	--	--	25	25	50
ExL102	Laboratory II -	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	50	**50**	**600**

Semester II

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ExC201	Power Electronic Devices and Design	04	--	--	04	--	--	04
ExC202	Advance Processor Architecture	04	--	--	04	--	--	04
ExC203	Applications of DSP and IP	04	--	--	04	--	--	04
ExE201X	Elective III	04	--	--	04	--	--	04
ExE202X	Elective IV	04	--	--	04	--	--	04
ExL201	Laboratory III	--	02	--	--	01	--	01
ExL202	Laboratory IV	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme Sem-II							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
ExC201	Power Electronic Devices and Design	20	20	20	80	03	--	--	100
ExC202	Advance Processor Architecture	20	20	20	80	03	--	--	100
ExC203	Applications of DSP and IP	20	20	20	80	03	--	--	100
ExE201X	Elective III	20	20	20	80	03	--	--	100
ExE202X	Elective IV	20	20	20	80	03	--	--	100
ExL201	Laboratory III	--	--	--	--	--	25	25	50
ExL202	Laboratory IV	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	--	**50**	**50**	**600**

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Semester III

Subject Code	Subject Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ExS301	Seminar	--	06	--	--	03	--	03
ExD301	Dissertation I	--	24	--	--	12	--	12
Total		**--**	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme Sem-III						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
ExS301	Seminar	**--**	**--**	**--**	--	50	--	50
ExD301	Dissertation I	**--**	**--**	**--**	--	100	--	100
Total		**--**	**--**	**--**	**--**	**150**	**--**	**150**

Semester IV

Subject Code	**Subject Name**	**Teaching Scheme(Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ExD401	Dissertation II	--	30	--	--	15	--	15
Total		--	30	--	--	15	--	15

Subject Code	**Subject Name**	**Examination Scheme Sem-IV**						
		Theory				**Term Work**	**Pract. / Oral**	**Total**
		Internal Assessment			**End Sem.Exam.**			
		Test1	**Test 2**	**Avg.**				
ExD401	Dissertation II	--	--	--	--	100	100	200
Total		--	--	--	--	**100**	**100**	**200**

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher

Electives: ME –Electronics Engineering

Elective I	Elective II
1. Advance Digital Communication	1. Wireless and Mobile Networks
2. Instrumentation System Design	2. Advance Digital Image Processing
3. Optical Fiber communication	3. Internetworking Technologies
4. Analogue IC Design	4. Digital System Design

Elective III	Elective IV
1. Advance Networking Technologies	1. Real Time Operating System
2. Machine Learning	2. Modeling and Synthesis with VHDL
3. Microwave IC	3. Cryptography and Network Securities
4. Fabrication of Microelectronic IC	4. Application Specific IC Design

Internal: Assessment consists of two tests, which are compulsory class test.

End Semester Examination: In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Laboratory (I, II, III and IV)

This is with the intention of developing research culture among the PG students.

Various project/practical topics related to the syllabus' subject should be provided to students and team should be formed for them to work in groups.

They can take assistance from the laboratory equipment and software present in the laboratory specifically equipped by the Institute for ME course referring to the syllabus.

Every year project/ practical topics should be revised to maintain continuity with the previous year projects.

Projects/ practical can be hardware/software based or combination of the two.

Students should be graded based on these projects/ practicals.

Project/ practical activity should be allotted two hours per week.

The TW and Practical/ oral should be assessed jointly by internal and external examiner.

Detailed Syllabus- ME Electronics Engineering

Semester –I

Compulsory

I -C1.

System Modeling and Simulation

1. Introduction – System modeling, Concept of a Model and Model building, Model classification, Identification, Simulation softwares
2. Continuous Time and Discrete Time Systems – Continuous-Time Linear systems, simple electrical circuits, Laplace transform, transfer functions, state-space model,
3. Discrete time systems, Z-transform, a-b tracking system, Feedback system, stability, controllability and observability.
4. Nonlinear System Analysis and Modeling – Mathematical models for nonlinear systems, phase trajectory and local linearization, system stability, controllability and observalibility, Input-output mapping and system invertibility, Linearization and linearizability, nonlinear system modeling and simulation
5. Computer Simulation – Numeric integration, state space simulation techniques, simulation of discrete-time systems, digital simulation languages
6. Robotic Systems and Automation – Modeling of robot, control of robots, modeling of mobile robots and control, applications
7. Design and analysis of Simulation Experiments – Design of simulation Experiments, analysis of simulation experiments, variance reduction techniques.
8. Digital Control systems – Basic Digital Control system, design approaches, implementation

Text Books:

1. Naim A Kheir, System Modeling and Computer Simulation, Marcel Dekker Inc, 1996
2. Modeling & Simulation Using Metlab-Dr.Sailendra Jain(Wiley)

Reference Books

1. Louis Birta, Gilbert Arbez, Modeling and Simulation, Springer
2. Donald Boyo, System Analysis and Modeling, Academic Press, 2001.
3. System Modeling and Simulation –Frank L.Severance(Wiley)
4. I. Mitrani, Simulation Techniques for Discrete Event Systems, Cambridge
5. Theory of Modeling and Simulation, 2nd Edition, Zeigler & Kim & Praehofer, 2000, Academic Press, Elsevier

I -C 2.

Modeling of Microelectronic Devices

1. **Basic Semiconductor physics:** Quantum Mechanical Concepts, Carrier Concentration, Transport Equation Band gap, Mobility and Resistivity, Carrier Generation and Recombination, Avalanche Process, Noise Sources

2. **Semiconductor Devices** P-n junction diode : its behavior ,Majority carrier diodes, Microwave Diode: The Varactor Diode, the p-i-n Diode, the IMPATT Diode, The TRAPATT Diode, The BARITT Diode, Transferred – Electron Devices Optoelectronic Devices: Static and Dynamic Models, Rate Equations, Numerical Technique, Equivalent Circuits, Modeling of LEDs, Laser Diode and Photo Detectors.

3. **Modeling Bipolar Device Phenomena** Injection and Transport Model, Continuity Equation, Transistor Models: Ebber - Molls and Gummel Port Model, Mextram model, SPICE modeling temperature and area effects.

4. **MOSFET Modeling**

Introduction Interior Layer, MOS Transistor Current, Threshold Voltage, Temperature Short channel and Narrow Width Effect, Models for Enhancement, Depletion Type MOSFET, CMOS Models in SPICE.

5. Parameter measurement

General Methods, Specific Bipolar Measurement, Depletion Capacitance, Series Resistances, Early Effect, Gummel Plots, MOSFET: Long and Short Channel Parameters, Statistical Modeling of Biopolar and MOS Transistors.

6. CAD for VLSI

Graph algorithms and their application in IC design, Number solution and Monte carlo simulations, Design for testability,

Text Book:

1. Introduction to Semiconductor Materials and Device By M. S. Tyagi, John WILEY & SONS, 1991

2. Solid State Electronic Devices, 6th ed., Ben G. Streetman, S.K. Banerjee, Prentice Hall, 2000

3. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

References:

R. T. Howe and C. G. Sodini, Microelectronics: an Integrated Approach, Prentice-Hall, 1997.

Fundamentals of Microelectronics-Behzad Razavi (Wiley)

S.M.Sze, Semiconductor Devices: Physics and Technology, John Wiley & Sons, Inc

Physics and Technology of Semiconductor Devices, A.S. Grove, John Wiley, 1967

Silicon VLSI Technology - Fundamentals, Practice and Modeling" by James D Plummer et al. Pearson Education 2001.

Donald A.Neamen,"Semiconductor physics and devices", McGraw-Hill,3rd edition,2007

Snowden C. M., Introduction to Semiconductor Device Modeling, World Scientific Press, Singapore, 1986

M. H. Rashid, *SPICE for Circuits and Electronics using PSpice*, Prentice Hall, 1995

A. Vladimirescu, *The SPICE Book*, New York : J. Wiley, 1994.

S.H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley & Sons-2002.

I -C 3.

Embedded Systems

EMBEDDED ARCHITECTURE

Embedded Computers – Characteristics of Embedded Computing Applications – Challenges in Embedded Computing system design- Embedded memories – Embedded System design process – Requirements – Specification – Architectural Design – Designing Hardware and Software Components – System Integration –Design Example.

EMBEDDED PROCESSOR AND COMPUTING PLATFORM

MSP 430 RISC Controllers, parallel I/O, external interrupts.

ARM processor fundamentals – introduction to ARM and THUMB instruction set--processor and memory organization – CPU Bus configuration – ARM Bus –Memory devices – Input/output devices – Component interfacing – designing with microprocessor development and debugging – Design Example

Instruction set with enhanced DSP features with ARM core, mix mode programming as Thumb+ ARM core, Assembly programming concept, compare with ARM7, ARM9, ARM11 with new features additions

INTERFACING

Sensors and interfacing techniques, Analog interfacing and data acquisition , Timing generation and measurements, --Distributed Embedded Architecture – Networks for Embedded Systems- serial bus protocols like I2C, RS485, CAN and USB--wireless protocols and interfacing of IRDA and SMART card – Design Example wireless protocols and interfacing of IRDA and SMART card – Serial communications: I2C – CAN Bus – Design Example

REAL TIME CONCEPTS

Real-time concepts, hard and soft real time systems, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS).

Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling

Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems

SYSTEM DESIGN

Design Methodologies – Requirement Analysis – Specification – System Analysis and Architecture Design – modeling techniques --Testing and debugging ---Quality Assurance – Design Example: Data base applications (smart cards), process-control (Fuzzy logic), robotics (wireless), CCD camera (data compression), network appliances (e-server), MSP 430 applications e.g. electricity metering, wireless communication, capacitive touch screen as examples of embedded systems.

References:

1. Introduction to Embedded Systems, Jonathan W. Valvano , Cengage 2009,
2. ARM System Developer's Guide, 1st Edition, Sloss & Symes & Wright , 2004, Morgan Kaufmann
3. Embedded Real Time Systems: Concepts, Design & Programming, Dr.K.V.K.K. Prasad, Dreamtech Publication.
4. Introduction to embedded systems, shibu k v, 2009, McGraw-Hill
5. An Embedded Software Primer, David E. Simon, Pearson Education Publication.
6. Embedded Systems-James K Peckol(Wiley)
7. Embedded Systems Design, 2nd Edition, S Heath, 2002 , Newnes Publication
8. Building Parallel, Embedded, and Real-Time Applications with Ada, John W. McCormick Frank Singhoff , JérômeHugues , Cambridge University Press

9. TEXAS MSP430, ARM Technical Publications
10. Embedded system design by Frank Vahid & Tony Givargis, Pearson Education
11. Kritee Ramamritham – Real Time Operating Systems, IEEE Press

Semester –I

Elective-I (any one)

I –E-I 1.

Advance Digital Communication

1. Block & Convolution codes
   - Linear Block codes
   - Convolution Block codes
   - Coded modulation for Bandwidth Constrained Channels
2. Signal Design for Band Limited Channels
   - characterization of Band Limited Channels
   - Signal Design for Band Limited Channels
3. Communication through Band Limited Linear Filters
   - Optimum receiver for Channels with ISI & AWGN
   - Linear Equalization
   - Design Feedback Equalization
4. Adaptive Equalization
   - Adaptive Linear Equalization
   - Adaptive Design Feedback Equalization
5. Multichannel & Multicarrier System
6. Spread Spectrum Signals for Digital Communication
7. Digital Communication through fading multipath channels

REFERENCES:

Digital Communication - John G. Proakis, McGraw Hill(1989)
Principles of Digital Communication & coding - Viterbi & Omura, McGraw Hill(1979)
Wireless Communication : Principles & Practice, 2 ed Edition, Theodore Rappaport, Prentice Hall
Digital Communication and Signal Processing, K. Vasudevan, Universities Press

I –E-I 2.

Instrumentation System Design

1. Smart sensors, Micro sensors and actuators and recent trends in sensor technologies.

2. Introduction to Model Predictive Control & Controllers Model based control schemes

3. Special Purpose Instrumentation

4. Generalized Predictive Control and Multivariable regulatory control. Role of PLC in Automation

5. Control of time-varying and non-linear systems

6. Virtual Instrumentation

Text Book

1. John G Webster , Measurement , Instrumentation and Sensors Handbook , CRC press

IEEE press, 1998

2. Model Based Predictive Control – A Practical Approach by J A Rossitor, CRC Press

3. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of

India, 2004

4. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”,

Wiley John and Sons, 2nd Edition, 2003.

5.R. Baican ,D. S Necsulescu “Applied Virtual Instrumentation ”WIT Press,2000

REFERENCE BOOKS

1. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”,

Wiley John and Sons, 2nd Edition, 2003.

2.Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw - Hill

International Edition, 2004.

3. Ness S.A. Air monitoring for Toxic explosions, Air integrated Approach, Von

Nostrand (1991).

4. Ewing G., Analytical Instrumentation hand book, Dekker (1991).

5. Alans V., Water and Waste water examination manual, Lewis Chele

6. E. Ikonen and K. Najim, “ Advanced Process Identification and Control”, Marcel Dekker, Inc. Newyork, 2002

7. P. Albertos and S. Antonio, “ Multivariable Control Systems An Engineering

I –E-I 3.

Optical Fiber communication

A Review of Optical Fibers

- Introduction
- Ray theory
- Theory of optical wave propagation
- Classification of optical fibers
- Signal Degradation
- Non Zero Dispersion Shifted Fibers
- Plastic optical fibers
- Splicing efficiency and optical fiber alignment
- Fiber optic cable

Advanced Optical Sources and Detectors

- Quantum well lasers
- Charge capture in Quantum well lasers
- Multi Quantum well Laser diodes
- Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers
- Resonant cavity enhancement (RCE) Photo Detector
- Material requirement for RCEPD
- Wavelength selectivity
- High speed comparison of conventional and RCEPD
- RCE Schottky Photodiode
- RCE Avalanche Photodiode

Optical Amplification

- Properties of Erbium Doped glass
- Optical Pumping
- Erbium Doped Amplifier
- Semiconductor Laser Amplifier
- Raman Amplifier
- Raman Gain and Bandwidth
- Multiple pump Raman Amplifier
- Raman Induced signal gain
- Noise Figure of Raman Amplifier
- Optical Signal to noise ratio
- Electrical Signal to noise ratio
- Application

Integrated Optics

- Planar and channel waveguides
- Coupled mode theory for waveguides
- Beam Splitters, Directional couplers and Photonic Switch
- Optical Modulators
- Arrayed waveguide Grating (AWG)
- Multimode interference coupler (MMI)
- Opto Electronic Integration
- Fabrication Techniques
- Material

Non linear Optics

- General Overview of nonlinearties
- Effective area and length
- Stimulated Raman Scattering
- Stimulated Brillouin Scattering
- Self Phase modulation
- Cross –Phase modulation
- Four wave mixing and its mitigation
- Solitons
- Properties of Solitons
- Loss managed Soliton
- Dispersion managed Soliton
- Dispersion Management:
- Dispersion problems and its solution,
- Dispersion compensating Fibers ,its design,
- Fiber Brag Grating,
- Dispersion Equalizing Filters
- Optical Phase conjugation
- PMD Compensation

Optical Networks

- Network concepts
- Network Topologies
- FDDI
- SONET/SDH
- DWDM Networks

Advanced Topics in OFC:

- Biophotonics
- Optical computing
- Optical MEMS
- Photonics Crystals Fibers and Waveguides

References;

1. Fiber optic Communication Systems, Govind . P. Agrawal, Wiley India.

2. Fiber Optic Communication - J.Keiser , McGraw Hill
3. Optical Fibers for transmission -J.E.Midwinter, John Whiley
4. “An Introduction to Fiber Optic Systems”-John Power-McGrawHill-(Second Edition 2000)

5. Mathematical Principles of Optical Fiber Communication, J. K. Shaw, 2004, Cambridge
6. Optical Communication systems - J.Gowar, Prentice Hall
7. Optical Fibers Telecommunications - S.E.Miller and A.G.Chynoweth ,Academic Press
8. Non linear fibers optics - G.Agarwal , Academic Press.
9. “Fiber Optics Communications”- Harold Kolimbris-Pearson Education(First Indian Reprint 2004)
10. “Optical Fiber Communications Principles and Practice”-John.M.Senior-Pearson Education(Third Edition,2009)
11. “Fundamentals of Optoelectronics”-Pollock-Irwin Publications (2003)
12. “Opto-Electronics, an introduction”-Wilson and Hawkes,Prentice Hall (Third Edition,)
13. “An Introduction to Nonlinear Optics”-Geoffrey New-Cambridge University Press (2010)
14. “Photonic Crystal Fibers”-Anders Bjarkler and JesBrong-Kluwer Academic Publishers (2011)
15. “Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink” by Le Nguyen Binh, CRC Press, 2010
16. “Introduction to Biophotonics”, Paras N. Prasad, Wiley-Interscience, 2003

I –E-I 4.

Analogue IC Design

1: Band gap references - PTAT current generation and constant Gm biasing
2: First and second order switched capacitor circuits - switched capacitor amplifiers-switched capacitor filters.
3: CMOS oscillators -ring oscillators-LC oscillators-VCO CMOS PLLs - non-ideal effects in PLLs - Delay locked loops and applications.
4: CMOS data converters -Medium and High-speed CMOS data converters- Over sampling converters. CMOS comparators-multipliers and wave shaping circuits

Text Books

1. David A Johns & Ken Martin, ‘Analog Integrated Circuit Design’ John Wiley and Sons, 2001

2. Behzad Razavi, ‘Design of Analog CMOS Integrated Circuit’ Tata-McGrawHill, 2002

3. 3.Philip Allen & Douglas Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002

4. R. Gregorian, G.C. Temes, "Analog MOS ICs for Signal Processing", Wiley 1986.

Elective –II (any one)

I –E-II 1.

Wireless and Mobile Network

1. Introduction to wireless and Mobile communication, Introduction to GSM system, Cell design concept, Interference issues in Wireless system.
2. Mobility management, handoff management- Detection , Assignment and Radio link transfer
3. IS-41 signaling, Intersystem handoff and Authentication in IS-41, PACS Network Signalling
4. Cellular Digital Packet data, GSM system overview, GSM network Signalling, GSM Mobility management, GSM Short message service and international Roaming for GSM
5. GSM Operations, Administration and Maintenance
6. General Packet Radio Service (GPRS)
7. Wireless application Protocol (WAP)
8. 3G Mobile services and Wireless Local Loop (WLL)
9. Mobile IP : Introduction ,Mobility requirements and constraints in an IP environment, Mobile IP Protocol Overview, Route Optimization, Mobility Support for IPv6, Connectivity with 3G Networks

Reference Books:

1. Wireless and Mobile network Architectures, Yi-Bang Lin and Imrich Chlamtac, Wiley-India Edition.
2. Mobile and Personal Communication Systems and Services, Raj Pandya, PHI, 2001.
3. Wireless Communications & Networks, William stallings, 2/e, Pearson,Prentice Hall, 2009.
4. Handbook of Wireless Networks and Mobile Computing ,Ivan Stojmenivic, Wiley india Edition,2009
5. Mobile IP : Design Principles And Practice By Charles E. Perkins Addition Wesley Wireless Commu.Series.

6. Wireless Communication by Andreas Molisch (WILEY)

7. Wireless Networking, 1st Edition, Kumar & Manjunath & Kuri, 2008, Morgan Kaufmann

I –E-II 2.

Advance Digital Image Processing

1. Fundamentals of Image Processing: Introduction – Steps in Image Processing Systems, image Acquisition – Sampling and Quantization – Pixel Relationships – Colour Fundamentals and Models, File Formats. Image Enhancement and Restoration : Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening.
2. Image Segmentation and Feature Analysis: Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation, Feature Analysis and Extraction.
3:Frequency Domain: Filtering in Frequency Domain – DFT, FFT, DCT, Smoothing and Sharpening filters – Homomorphic Filtering., Noise models, Constrained and Unconstrained restoration models.Image Pyramids – Multi resolution expansion – Wavelet Transforms, Fast Wavelet transforms,Wavelet Packets.Image Compression
4: Image Classification techniques:Introduction,feature extraction,supervised and unsupervised training,hybrid-supervised and unsupervised training,Non parametric classification-level slice classification,histogram estimation classifier,nearest neighbhour classiier,ANN classifier (BPN),introduction to fuzzy set classifier.
5: Introduction to remote sensing information extraction from Remote-sensing Images spectral Factors in Remote sensing, spectral signatures, remote sensing systems- spatial and radiometric characteristics, spectral characteristics.

6: Applications of Image Processing: Representation and Description, Image Recognition-

Video Motion Analysis – Image Fusion , Steganography , Colour Image Processing.

References:

1. Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing", Third Edition, Pearson Education, 2008.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Third Edition, Third Edition, Brooks Cole, 2008.
3. Anil K.Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 2007.
4. Madhuri A. Joshi, 'Digital Image Processing: An Algorithmic Approach", Prentice-Hall India, 2006.
5. Rafael C.Gonzalez , Richard E.Woods and Steven L. Eddins, "Digital Image Processing Using MATLAB", First Edition, Pearson Education, 2004.
6.Robert schowengerdt,Remote sensing modules and methods for Image processing Elsevier publication IIIrd edition

7. Applied Digital Signal Processing, Dimitris G. Manolakis, Vinay K. Ingle, Cambridge University Press

I –E-II 3.

Internetworking Technologies

1: Introduction to Internetworking

Introduction to OSI model ,TCP/IP protocol suite. Application layer-

Web and HTTP, DNS and Socket Programming

2: Transport Layer

UDP, TCP, Reliable Data Transfer, Congestion Control

3: Network Layer and Routing

Internet Protocol, Addressing and Routing, IPv6, Multicast and Mobility

4: Advanced Network Architectures:

IP forwarding architectures, Overlay model, MPLS, Integrated services in Internet, RSVP, Differentiated services etc.

5: Wireless and Mobility:

Wi-Fi, wireless links characteristics, Cellular access, Mobility principles

6: Multimedia Information and Networking:

Compression Fundamentals, Digital representation, compression techniques, Multimedia communication across networks: RTP, RTSP, SIP, H.323

Reference Books

1. J F. Kurose & KW. Ross: **Computer Networking- A Top-down Approach featuring the Internet**, 3rd edition, Pearson, 2005.
2. A. Leon-Garcia & I. Widjaja :**Communication Networks** 2/e McGraw-Hill Publications
3. K. R. Rao et al: **Multimedia Communication Systems,** Prentice-Hall of India,
4. Behrouz A. Forouzan **TCP/IP Protocol suit** Tata McGraw Hill PVt Forth edition.

I –E-II 4.

Digital System Design

1. Overview of synchronous FSM design – architectures and system level design – State machine designs centered around non registered PLDs ,

2. Programmable logic devices (PLDs). Programmable gate arrays.FPGA- based system design. FPGA fabrics. Types of FPGAs and their architectures.

3. Combinational logic design overview, combinational network delay, Power and energy optimization, overview of arithmetic circuits , implementation for FPGAs,

4. .Sequential machine design Process, design styles. Rules for clocking. Performance analysis. Power optimization.

5. ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN
   Analysis of Asynchronous Sequential Circuit (ASC) - Flow Table Reduction - Races in ASC - State Assignment - Problem and the Transition Table - Design of ASC - Static and Dynamic Hazards - Essential Hazards - Data Synchronizers - Designing Vending Machine Controller - Mixed Operating Mode Asynchronous Circuits.

6. FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS
   Fault Table Method - Path Sensitization Method - Boolean Difference Method – Kohavi Algorithm - Tolerance Techniques - The Compact Algorithm - Practical PLA's - Fault in PLA - Test Generation -Masking Cycle - DFT Schemes - Built-in Self Test.

Text Books

1. Richard Tinder, Engineering Digital Design, Academic Press, second edition

2. W.Wolf, FPGA- based System Design, Pearson, 2004

3. Mark Zwolinski, "Digital System Design with VHDL", Pearson Education, 2004.

4. Digital Integrated Circuit Design, Hubert Kaeslin, Cambridge University Press

5. Digital Design- Vahid- Wiley

Semester – II

Compulsory

II –C 1.

Power Electronic Devices and Design

1.Review of power devices - Power transistor, Power MOSFET,SCR,IGBT .Review of Drive circuits for SCR, BJT, IGBT/MOSFET. Isolation between control circuit and power circuit -techniques and circuits..Protection circuits:-Anti saturation protection for BJT& IGBT. Overload protection, thermal protection.

2. Chopper circuits using IGBT. Classes of chopper-A, B, C,D & E. Working quadrants.

3. Inverters:-Single phase and three phase using IGBT. Single pulse & multi pulse PWM inverters. Sine wave and modified sine wave techniques.

4. DC motor drives:-constant torque/constant power region.

(i)converter circuits, (ii)Chopper circuits (iii)Rheostatic chopper brake circuit

5.AC motor drives for induction motors :-single phase and three phase, variable stator voltage control, v/f control, slip power recovery schemes-static Kramer and scherbius.

6.UPS & SMPS:- schematic diagrams, working of SMPS, advantages of UPF operation.

7. Unity Power Factor converters-Basic principle of working.

8.Smart Grid & renewable energy sources:-Schematic diagrams of smart grid using solar power and wind energy.

Textbooks

1.Power Electronics by Joseph Vidyathil

2.M.H.Rashid ,Power Electronics, PHI India.

3. Power Electronics-L umanand, wiley

4.Ned Mohan, Converters Application and Design ,Jhon Willey

5.M.D.Singh and K.B. Khanchandani, Power Electronics,TMH

References:-

6..Rai G.D ,Solar Energy Utilization, Khanna Publishers,1993.

7.B.H Khan, Non conventional Energy sources, Tata McGraw-Hill.

II –C 2.

Advanced Processor Architectures and Organization

1. A Top Level View of Computer functions and Interconnections Computer Components, Computer Functions, Interconnection Structures Bus Interconnections
2. Advanced Processor Architectures CISC and RISC processor design fundamentals, Pipelined Processors, Superscalar Processors, Out of Order Execution, Instruction Level Parallelism, Branch Prediction Logic, Multi-core Architectures
3. Case studies : Power PC architecture RISC architecture
4. Memory Semiconductor Memories / DRAM organization, Cache Memory : Principles, Coherency, Cache Design, External Memories: Magnetic , Optical, RAID Virtual memory management
5. I/O Types of I/Os, I/O Interfacing Concepts, I/O Buses: PCI, PCI-X, PCI-E, Universal Serial Bus(USB)
6. Operating System support OS Overview, Scheduling, Memory Management, Case studies: Pentium Power PC
7. Parallel Processing Multiple Processor Organizations, Symmetric Multiprocessors, Cache Coherence and the MESI Protocol, Multithreading and Chip multiprocessors, Clusters, Non-Uniform Memory Access, Vector Computation

Text Books:

1. Computer Organization and Architecture : Designing for Performance by William Stallings
1. Advanced Microprocessors – Daniel Tabak

References: Various company's Manuals

II –C 3.

Applications of DSP and IP

1. Overview of DSP and its Hardware.
2. Statistical Signal Processing and Adaptive Filtering.
3. DSP Application
- Speech and Audio Signal Processing
- Biomedical Signal Processing
- DTMF receiver and Transmitter
- Radar
1. Image Compression techniques based on DCT and Wavelet transform.
2. Advanced Image Modeling Techniques.
3. Image Reconstruction
4. Application of Image Processing
- Object Recognition
- Medical Application
- Forensics
- Remote Sensing
- Industrial Sensing.

References:-

1. Statistical Digital Signal Processing & Modeling, Monson Hayes., --Wiley
2. Digital Signal Processing with FPGA, U Meyer- Baese 3rd Edition., --Springer
3. Biomedical Signal Processing & Signal Modeling, Eugene N Bruce., --Wiley.
4. Fundamentals of Speech Recognition, Rabiner, Jaung PHI
5. Digital Image processing-Pratt
6. Theory and Implementation of Digital Signal Processing, Rabiner-Gold. ,-- PHI
7. Digital Image Processing, Rafael Gonzalez, Richard E Woods.,-- PHI
8. DIP for Medical Applications, Geoff Dougherty., -- Cambridge

Semester –II

Elective-III (any one)

II –E-III 1.

Advanced Networking Technologies

1 Overview of OSI model and TCP/IP protocol suite, optical networking: SONET/SDH standards, DWDM, performance and design considerations, optical routing.

2 Mobile Networks :

Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunneling and Encapsulation, Optimizations, Reverse tunneling, IPv6, Dynamic host configuration protocol, Ad hoc networks MANET: ROUTING, DESTINATION SEQUENCE DISTANCE VECTOR, Dynamic source routing, Hierarchical algorithms, Alternative metrices**.**

3 Wireless Sensor Networks**:** Introduction and Applications, Mobile Internet connectivity and Personal area Networks. Mobile computing Architecture: Three Tire Architecture for Mobile computing, Design considerations, Mobile computing through Internet.

4 Routing in the Internet: Intra and interdomain routing, Unicast Routing Protocols: RIP, OSPF, BGP,Multicast Routing Protocols, MOSPF, DVMRP, Drawback of traditional routing methods, IP over ATM, Storage Area Network (SAN).

5 Traffic Engineering and Capacity Planning:

Traffic Engineering basics: Requirement definition: Traffic sizing, characteristics, Protocols, Time Delay considerations, Connectivity, Reliability, Availability and Maintainability, Throughput calculations

Quality of service: Introduction, Application, Queue Analysis: M/M/1 as a packet processing Model, QoS Mechanisms Queue management Algorithms, feedback, Resource reservation: Queued data and Packet switched traffic modeling. Application and QoS.

Network Performance Modeling, Creating Traffic Matrix, Capacity Planning and Network vision, Design Tools.

6 Cloud computing: Cloud Computing Evolution, Definition, SPI framework of Cloud Computing, Cloud service delivery models, Cloud deployment models, key drivers to adoption of cloud, impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.

Reference Books

1. Behrouz A. Forouzan **TCP/IP Protocol suit** Tata McGraw Hill PVt Forth edition.
2. Darren Spohn Data Network Design McGraw Hill Publications
3. Wireless and Mobile N/W Architecture yi Bang Lin and Inrich b(Wiley)
4. Cloud Security and Privacy: An Enterprise Perspective by Tim Mather, Subra Kumaraswamy

II –E-III 2.

Machine Learning

1. Introduction: Types of learning - supervised; unsupervised learning; reinforcement learning and adaptive control. Designing learning system, perspectives and issues in Machine Learning
2. Decision tree learning – Decision tree representation, basic decision tree learning algorithm, inductive bias in decision tree learning, issues in decision tree learning
3. Artificial Neural Network – neural network learning, Single layer perceptron, multilayer perceptron, backpropagation algorithm, Radial basis and recurrent neural network, application of neural network such as character recognition, face recognition.
4. Bayesian learning – Bayes theorem, Concept learning, Minimum description length principle, Gibb’s algorithm, Baysian Belief network, EM algorithm
5. Instance based learning – k-nearest neighbor learning, locally weighted regression, radial basis functions, case based reasoning
6. Reinforcement learning – Learning task, Q-learning, Temporal difference learning, dynamic programming
7. Recent applications of machine learning, such as to robotic control, autonomous navigation, speech recognition, face recognition, character recognition, etc.

Text Books:

1. Tom Mitchell, Machine Learning. McGraw-Hill, 1997.
2. Ethem Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2004.

Reference Books:

1. Christopher Bishop, Pattern Recognition and Machine Learning. Springer, 2006.
2. Richard Duda, Peter Hart and David Stork, Pattern Classification, 2nd ed. John Wiley & Sons, 2001.
3. Richard Sutton and Andrew Barto, Reinforcement Learning: An introduction. MIT Press, 1998
4. Hagan, Demuth, Beale, Neural Network Design., Thomson Learning
5. Scaling up Machine Learning - Parallel and Distributed Approaches, *Ron Bekkerman* , *Mikhail Bilenko* , *John Langford* ,Cambridge University Press

6. V. Shusheela Devi, N.M. Murty, Pattern Recognition-An introduction, Universities Press

II –E-III 3.

MICROWAVE INTEGRATED CIRCUITS

1. Hybrid MICs : Definition, Characteristics, Comparison with conventional circuits, fields of application and limitations and criteria for the choice of substrate material, thin film hybrid circuits, thick film hybrid circuits, artwork, mask making, photolithography, resistor stabilization, sawing, brazing process, wire bonding.
Monolithic MICs: Definition, substrate structure, doping by ion implantation ohmic contact, metal resistive layers, gate metal, dielectric second level metal, dielectric and air bridge vias, substrate vias, final wafer process steps.

2. Microstrip Lines: Planar wave guides, non-TEM propagation, line impedance definitions, quasi-static approximations, quasi-static line parameters, micropstrip open circuits and gaps, microstrip corners, step changes in width, dispersion analysis, microstrip characteristic impedance, symmetric T junction, full wave analysis of microstrip propagation, LSE and LSM potentials, spectral domain analysis, dispersion relation for open microsrip, spectral domain impedance analysis, dispersion relation for open microstrip, spectral domain impedance analysis, Green's functions, millimeter wave modeling of microstrip lines.

3. Coupled Line Propagation: Wave equations for coupled lines, propagation models, coupled line parameters, coupled line parameter variations with frequency, directional couplings, Lange coupler coupled line pair treated as a four port, coupled line pair operated as a two port assuming 0e = 0o, low pass filter design assuming 0e =0o, coupled line pair analysed to a two port 0e not equal to 0o, narrow band filter using coupled resonator, narrow band coupled line filters, suspended substrate strip lined filters, suspended substrate strip line filter design using method 1 and method 2.

4. Slot Lines : Analysis, design consideration, transitions and applications. Coplanar Waveguide,

Analysis, design considerations and coplanar line circuits.

5. Devices: GaAs FET, Bipolar Transistors, Varactor diodes, PIN diodes, YIC resonators, Dielectric resonators.

6. Microwave Computer Aided Workstations for MMIC Requirement. Introduction, Integrated Microwave Workstation Approach, Nonlinear Tools, Role CAD, Yield Driven Design, Rethinking Design, Designing Nonlinear Circuits Using Harmonic Balance Method. Programmable Microwave Tuning System, GaAs MMIC Layout Software, Practical Design. CAD Applications.

Text And Reference Books

1. Microstrip Circuit Analysis – David H. Schrader , Prentice Hall PTR, New Jersey 07458.

2. Microstrip Lines and Slot Lines, K.C. Gupta, R. Garg and I.J. Bahl , Artech House.

3.Microwave Circuit Design using Linear and Non Linear Techniques: George Vendelin, Pavio and Rohde, Wiley

4. MIC and MMIC Amplifier and Oscillator Circuit Design 1990 edition, Allen Sweet, Artech House.

5. MMIC Design : GaAs FETs and HEMTs, Peter Ladbrooke , Artech House.

6. Handbook of Microwave Integrated Circuits Reinmut K. Hoffman , Artech House.

7. Foundations for Microstrip Circuit design T.C. Edwards, John Wiley and Sons

II –E-III 4.

Fabrication of Microelectronic IC

1 . Introduction to IC Design:

Types of ICs, P-N Junction, Transistor, Designing an IC, Future trends and issues in IC Design, Introduction to Microelectronic Fabrication, Semiconductor Substrates and Optical and Electronic Properties.

(1.Semiconductor Manufacturing Handbook by Hwaiyu Geng (McGrawHill)

2. The Science and Engineering of Microelectronic Fabrication by Stephen A. Campbell (Oxford University Press))

3. Integrated Circuit Manufacturing for VLSI :

Vacuum Technology, Physical & Chemical Vapor Deposition, Diffusion, Thermal Oxidation, Silicide & Epitaxial formation on silicon. PhotoMask, Opitcal Lithography – Ion implantation, Rapid Thermal Annealing, Wet Etching, Plasma Etching, Nanolithography. Device Isolation, Contacts, Metalization, CMOS Techniques, GaAS Technologies, Silicon Bipolar Technologies Environmental, Health & Safety Considerations in Semiconductor Facilities.

(3. Semiconductor Manufacturing Handbook by Hwaiyu Geng (McGrawHill)

4. The Science and Engineering of Microelectronic Fabrication by Stephen A. Campbell (Oxford University Press)
5. Nano : The Essentials by T. Pradeep (McGraw-Hill))

6. Characterization of Micro/Nano Structures :

Small Angle X-ray Scattering (SAXS), Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Scanning Probe Microscope (SPM), Microwave Spectroscopy, Auger Electron Microscopy, Raman Microscopy, Atomic Force Microscopy, Helium Ion Microscopy

(Nanostructuring Operations in Nanoscale Science and Engineering by: Kal Renganathan Sharma)

7. **Micro Electro-Mechanical Structures (MEMS):**

Fundamentals of mechanics; stress in thin films; mechanical to electrical transduction; mechanics of common MEMS devices; bulk micromachining etching techniques; bulk micromachining process flow; surface micromachining basics; surface micromachining process flow; MEMS actuators; and high aspect ratio microsystems technology (HARMST).

(The Science and Engineering of Microelectronic Fabrication by Stephen A. Campbell)

8. **Carbon Nanotubes :**

Synthesis & Purification, Mechanism of Growth, Electronic Structure, Transport Properties, Mechanical Properties, Physical Properties, Characterization and Applications (Electron Field

(Nano : The Essentials by T. Pradeep (McGraw-Hill))

REFERENCES:

1 The Science and Engineering of Microelectronic Fabrication by Stephen A. Campbell (Oxford University Press)

2 Semiconductor Manufacturing Handbook by: Hwaiyu Geng (McGrawHill)

3 Nano : The Essentials by T. Pradeep (McGraw-Hill)

4 Nanostructuring Operations in Nanoscale Science and Engineering by: Kal Renganathan Sharma (McGraw-Hill)

5 Carbon Nanoforms and Applications by Maheshwar Sharon, Madhuri Sharon (McGraw-Hill)

7 System on Package: Miniaturization of the Entire System

by Rao R. Tummala (McGraw-Hill)

Semester –II

Elective-IV (any one)

II –E-IV 1.

REAL TIME OPERATING SYSTEMS

1. Software Architectures, Software Developments Tools, Program Modeling Concepts, Software Development Process Life Cycle and its Model, Software Analysis, Design and Maintenance,

2. Hard versus Soft Real-time systems – examples, Jobs & Processors, Hard and Soft timing constraints, Hard Real-time systems, Soft Real-time systems. Classical Uniprocessor Scheduling Algorithms – RMS, Preemptive EDF, Allowing for Preemptive and Exclusion Condition.

3. Concept of Embedded Operating Systems, Differences between Traditional OS and RTOS. Real-time System Concepts, RTOS Kernel & Issues in Multitasking – Task Assignment, Task Priorities, Scheduling, Intertask Communication & Synchronization – Definition of Context Switching, Foreground ISRs and Background Tasks. Critical Section – Reentrant Functions, Interprocess Communication (IPC) – IPC through Semaphores, Mutex, Mailboxes, Message Queues or Pipes and Event Flags.

4. Real Time Operating Systems (µC/OS):Real-Time Software Concepts, Kernel Structure, Task Management, Time Management, Inter task Communication & Synchronization, Memory Management, and Porting µCos-II.

5. Linux/RT Linux: Features of Linux, Linux commands, File Manipulations, Directory, Pipes and Filters, File Protections, Shell Programming, System Programming, RT Linux Modules, POSIX Threads, Mutex Management, Semaphore Management.

6. Introduction to multiprocessor scheduling , resource access control and synchronization

References:

1. µC/OS-II, The real time Kernel, Jean J. Labrossy, Lawrence: R & D Publications.
2. Embedded Real Time Systems: Concepts, Design & Programming, Dr.K.V.K.K. Prasad, Dreamtech Publication.
3. An Embedded Software Primer, David E. Simon, Pearson Education Publication.
4. . Jane W.S.Liu, Real Time Systems, Pearson Education, Asia, 2001.
5. Real Time Systems, C.M.Krishna and G.Shin, McGraw-Hill Companies Inc., McGraw Hill International Editions, 1997.
6. Kritee Ramamritham – Real Time Operating Systems, IEEE Press

II –E-IV 2.

Modeling and Synthesis with VHDL

CIRCUIT DESIGN

1. Introduction to VHDL, Design Flow, EDA tools, Behavioral and Structural Description.
2. Code Structure: Fundamentals of VHDL Units, Library Declarations, Entity, Architecture.
3. Data Types, Operators and Attributes.
4. Concurrent Code and Sequential Code
5. Signals and Variables
6. State Machines
7. Datapath /Controller Partioning
8. Advanced VHDL Circuit Design Examples.

SYSTEM DESIGN

1. Packages, Components and Configurations
2. Functions & Procedures
3. Advanced VHDL System Design Examples

SYNTHESIS ON AN FPGA

1. Introduction to PLDs, CPLDS and FPGAS.
2. FPGA Design and I/O Resources
3. Memory and Clocking
4. Xilinx Spartan and Virtex Series FPGA
5. Configuring an FPGA: RTL synthesis, constraints, behavioral synthesis, place and route etc.
6. Application and End-Markets

References:

Volnei A. Pedroni, Circuit Design with VHDL, MIT Press, 2004.

Ashenden P.J., The Students Guide to VHDL, Elsevier, 1999.

Zwolinski M., Digital System Design with VHDL, Pearson, 2004

Xilinx Online Resources: www.xilinx.com

II –E-IV 3.

CRYPTOGRAPHY AND NETWORK SECURITY

1: **Introduction and Mathematics of Cryptography**

Introduction to System Security, security goals, Basic terminology, mathematics of cryptography, Basic number theory, prime numbers, congruence, modular arithmetic, Euclidian algorithm, Information theory, Entropy of information.

2: **Classical Cryptography**

Symmetric key cryptography : Stream ciphers, A 5/1, RC4, Block ciphers, Fiestel cipher, DES, Triple DES, AES

Public key crypto: RSA, Diffie Hellman, uses of public key crypto, Signature and Non-repudiation, Confidentiality and Non-repudiation, PKI

3: **Hash functions and Access control**

Hash Functions: The Birthday problem and its relevance, MD5, SHA-512, Uses of Hash functions

Access Control: Authentication and Authorization, authentication methods, passwords, biometric, authentication protocols, Kerberos. Access control matrix, ACLs, and Capabilities, CAPTCHA

4: **Network Security Basics and Application layer security**

Network security basics, TCP/IP Model and protocol flaws, Network vulnerabilities, Packet sniffing, session hijacking, ARP spoofing, web site and web server vulnerabilities, Email security, PGP, S/MIME

5: **Security at Transport layer**

Vulnerabilities at transport layer, SSL protocol and IPSEC protocol and their working

6: **Security at Network layer**

Firewall, IDS/ IPS systems, Honey Pots, IPSEC protocol and its operation

Reference Books

Cryptography and network Security by B.A Forouzan (TMH publication)

Cryptography And Network Security by William Stallings (Pearson /prentice hall)

Information security principles and practice by Mark Stamp (Wiley publication)

Foundations of Cryptography - Volume 1 and 2 : Basic Tools, *Oded Goldreich* , Cambridge University Press
Security in computing by Pfleeger and Pfleeger (Pearson Education)

II –E-IV 4.

Application Specific Integrated Circuit Design

1. Types of ASICs. ASIC design flow. Programmable ASICs. Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects.
2. An overview of advanced FPGAs and programmable SOCs : Architecture and configuration of Spartan II and Virtex II FPGAs . Apex and Cyclone FPGAs. Virtex II PRO kits and Nios kits. OMAP. ASIC physical design issues. system partitioning, interconnect delay models and measurement of delay.
3. ASIC Construction Physical Design, floor planning, placement and routing, CAD tools estimating ASIC size, Power dissipation
4. Design issues in SOC. Design methodologies. Processes and flows. Embedded software development for SOC. Techniques for SOC testing. Configurable SOC. Hardware/software codesign.
5. High performance algorithms for ASICS/ SOCS. SOC case studies- DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. Case Studies: Digital camera, Bluetooth radio/modem, SDRAM and USB controllers.

Text book
1. M.J.S. Smith : Application Specific Integrated Circuits,,Pearson, Education, 2003

References:

1. Maclon R. Haskard, Lan C. May, “ Analog VLSI Design- NMOS and CMOS” Prentice Hall, 1998
2. Andrew Brown” VLSI Circuits and Systems in Silicon” McGraw Hill,1991
3. S.D. Brown , R.J. Francis J. Rox, Z. G. Uranesie, “Field Programmable Gate Arrays” , Kluwer Academy Publishers, 1992.
4. RazakHossain, High Performance ASIC Design, Cambridge.

AC – 11 July, 2022
Item No. – 6.31 (R)

University of Mumbai

Revised Syllabus for
M.E.
(Electronics & Telecommunication Engineering)
Semester – (Sem. - I to IV)
(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: ______________ Title of Course	M.E. (Electronics and Telecommunication Engineering)
O: ______________ Eligibility	Passed B.E. / B.Tech. as per the Ordinance O.5134
R: _______________ Passing Marks	45%
No. of years/Semesters:	02 Years / 4 semesters
Level:	P.G. / ~~U.G./~~ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year:	With effect from Academic Year : 2022-23

Dr Faruk Kazi
Chairman
of Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC101	Advanced Digital Signal Processing and Applications	3	--	--	3	--	--	3
ETC102	Optical Communication Network	3		--	3		--	3
ETPE101	Program Elective 1	3	--	--	3	--	--	3
ETPE102	Program Elective 2	3	--	--	3	--	--	3
ETIE101	Institute Elective 1	3	--	--	3	--	--	3
ETL101	Program Lab-I	--	2	--	--	1	--	1
ETSBL101	Skill Based Lab-I	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETC101	Advanced Digital Signal Processing and Applications	20	20	20	80	3	--	--	100
ETC102	Optical Communication Network	20	20	20	80	3	--	--	100
ETPE101X	Program Elective 1	20	20	20	80	3	--	--	100
ETPE102X	Program Elective 2	20	20	20	80	3	--	--	100
ETIE101X	Institute Elective 1	20	20	20	80	3	--	--	100
ETL101	Program Lab-I	--	--	--	--	--	25	25	50
ETSBL101	Skill Based Lab-I	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	--	**75**	**75**	**650**

Subject Code ETPE101X	**Program Elective 1**
ETPE1011	Next Generation Networks
ETPE1012	Advanced Antenna Design
ETPE1013	Statistical Signal Processing

Subject Code ETPE102X	**Program Elective 2**
ETPE 1021	Image Analysis using Machine learning
ETPE 1022	Embedded Communication Systems Design
ETPE 1023	Optimization Methods in Signal Processing for Communication Systems

Subject code ETIE101X	Institute Elective 1
ETIE1011	Product Life cycle Management
ETIE1012	Reliability Engineering
ETIE1013	Management Information System
ETIE1014	Design of Experiments
ETIE1015	Operation Research
ETIE1016	Cyber Security and Laws
ETIE1017	Disaster Management & Mitigation Measures
ETIE1018	Energy Audit and Management

Semester II

Course Code	Course Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC201	RF Engineering	3	--	--	3	--	--	3
ETC202	Modern Digital Communication	3		--	3		--	3
ETPE201X	Program Elective 3	3	--	--	3	--	--	3
ETPE202X	Program Elective 4	3	--	--	3	--	--	3
ETIE201X	Institute Elective 2	3	--	--	3	--	--	3
ETL201	Program Lab-II	--	2	--	--	1	--	1
ETSBL201	Skill Based Lab-II	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETC201	RF Engineering	20	20	20	80	3	--	--	100
ETC202	Modern Digital Communication	20	20	20	80	3	--	--	100
ETPE201X	Program Elective 3	20	20	20	80	3	--	--	100
ETPE202X	Program Elective 4	20	20	20	80	3	--	--	100
ETIE201X	Institute Elective 2	20	20	20	80	3	--	--	100
ETL201	Program Lab-II	--	--	--	--	--	25	25	50
ETSBL201	Skill Based Lab -II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Note 1: Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work

Subject Code **ETPE201X**	**Program Elective 3**
ETPE2011	Satellite Networking
ETPE2012	Network and Cyber Security
ETPE2013	Remote Sensing

Subject Code **ETPE202X**	**Program Elective 4**
ETPE2021	Error Control Coding
ETPE2022	Wireless Adhoc and Sensor Networks
ETPE2023	Cognitive Radio

Subject Code ETIE201X	**Institute Level Optional Course 2**
ETIE2011	Project Management
ETIE2012	Finance Management
ETIE2013	Entrepreneurship Development and Management
ETIE2014	Human Resource Management
ETIE2015	Professional Ethics and CSR
ETIE2016	Research Methodology
ETIE2017	IPR and Patenting
ETIE2018	Digital Business Management
ETIE2019	Environmental Management

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETMP301	Major Project: Dissertation -I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETMP301	Major Project: Dissertation -I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	**--**	**100**	**--**	**100**

Online Credit Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETOCC301	Online Credit Course - I	--	--	--	--	--	--	3
ETOCC301	Online Credit Course - II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by UoM. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall be accounted in the third semester grade-sheet with actual names of courses. The learner shall be allowed to take up these courses from his or her institute or organisation/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner.

Online Credit Course – I

The learner shall opt for the course in the domain of Research Methodology **or** Research & Publication Ethics or IPR. The opted course shall be of 3 credits of equivalent number of weeks.

Online Credit Course –II

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETMP401	Major Project : Dissertation -II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ETMP401	Major Project : Dissertation -II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	--	**100**	**100**	**200**

Total Credits: 68

Note 3: The Dissertation -II submission shall not be permitted till the learner completes all the requirements ME course.

Note 4: The contact hours for the calculation of load of the teacher for Major Project are as follows: Major Project Dissertation I and II - 02 Hour / week / student

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format. Guidelines for Assessment of Dissertation-I.

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution

- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.

Subject Code	Subject Name	Credits
ETC101	**Advanced Digital Signal Processing and Applications**	**03**

Course Pre-requisite:

- Signals & Systems
- Discrete Time Signal Processing

Course Objectives:

- To develop in-depth understanding of techniques of power spectrum estimation.
- To provide adequate knowledge on adaptive filtering, wavelet transforms and theirs applications.
- To provide knowledge about applications of signal processing to real world problems

Course Outcome:

Learners will be able to:

- Illustrate the techniques of power spectrum estimation and adaptive filtering for various applications.
- Explain and implement wavelet transforms and their applications.
- Apply Signal processing tools to biomedical signal processing and musical sound processing.

Module	Detailed Content	Hours
1	**Power Spectrum Estimation** • Non- Parametric methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods for Periodogram estimation: Bartlett, Welch and Blackman and Tukey methods. • Parametric Methods of Power Spectrum Estimation: AR, MA & ARMA models for power spectrum estimation. Yule-Walker method for the AR model parameter	08
2	**Introduction to Adaptive systems** • Introduction, Characteristics, Examples of Adaptive systems, Applications. The adaptive system -linear combiner- Description, Weight vectors, desired response performance function- Gradient and mean square error.	06
3	**Adaptive Signal Processing and Applications** • FIR Adaptive filters - Adaptive Direct Form FIR Filters based on steepest descent method -Widrow Hoff LMS Adaptive algorithm. Adaptive Direct Form FIR Filters-RLS Algorithms. • Applications: System Identification, Adaptive channel equalization - Adaptive echo canceller.	06
4	**Wavelet Theory** • Fourier Transform and its Limitations – Short Time Fourier Transform – Introduction to time frequency analysis- Continuous Wavelet Transform	07

	– Discrete Time Wavelet Transform- Multi-resolution analysis– Haar Wavelet Transforms – Daubechies Wavelet, Filter bank theory. • Application of wavelet theory to signal denoising, speckle removal, and signal and image compression.	
5	**Application of Digital Signal Processing to Biomedical Signal Processing** • Introduction to various Bio-electric signals: ECG, EEG, EOG, and their pre-processing, Artifacts and interferences in ECG and their removal, Detection of fetal heartbeats during labor- Fetal ECG, QRS template, QRS detection methods, performance measure for QRS detection. • Adaptive removal of ocular artifacts from human EEGs- Methods for removal and control of ocular artefacts, online Ocular Artifacts Removal (OAR) algorithm and system,	8
6	**Application of Digital Signal Processing in Musical Sound Processing** • Musical sound processing - Time domain operations- single echo filter, multiple echo filter, Reverberation, Flanging, Chorus generator, Frequency domain operations-Analog filters, First order digital filters and Equalizers, Second order digital filters and Equalizers.	04
	Total	39

Textbooks and References:

Textbooks:

1. John G. Proakis and Dimitris G. Manolakis, –*Digital Signal Processing*‖, PHI, 2005.
2. Bernard Widrow and Samuel D.Strearns, –*Adaptive Signal Processing*‖, Pearson Edu Asia 2002.
3. S. M. Kay, *Modern Spectrum Estimation Theory and Application*‖, PHI.
4. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, –*Insight into Wavelets: From theory to practice*, Third Edition PHI, 2010.
5. Raghuveer. M. Rao and Ajit S.Bopardikar, –*Wavelet Transforms -Introduction to theory and applications*, Pearson Education, Asia, 2000.
6. Rangaraj M. Rangayyan, –*Biomedical Signal Analysis- A Case Study Approach*‖, Wiley 2002.
7. Willis J. Tompkins, *Biomedical Digital Signal Processing*, PHI, 1999
8. Sen M Kuo, Bob H Lee and W Tian, –*Real Time Signal processing: Fundamentals, Implementations and Applications*‖ Springer, Wiley Publishers, Third Edition 2013.
9. S. K. Mitra, –*Digital Signal Processing*‖, TMH, 2001
10. Emmanuel C. Ifeachor, Barrie W. Jervis, –*Digital Signal Processing, A Practical Approach*‖, Pearson Education, 2008.

Reference Books:

1. Simon Haykin, –*Adaptive Filter Theory*‖, Pearson Edu, 2013
2. D. C. Reddy, *Biomedical Signal Processing Principles and Techniques*, Tata Mc Graw-Hill, 2005
3. A. H. Sayed, –*Adaptive filters*‖, Wiley Student Edition, 2010

4. S. Thomas Alexander, *Adaptive signal processing-Theory and Applications*, Springer –Verlag.
5. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
6. Mark Kahrs, Karlheinz Brandenburg, –*Applications of Digital Signal Processing to Audio and Acoustics*‖, Kluwer Academic Publishers, 2002
7. Mallat, Stéphane. –*A wavelet tour of signal processing*.‖ Academic press, Third Ed. 2008.
8. Torrence, Christopher, and Gilbert P. Compo, "*A practical guide to wavelet analysis*." Bulletin of the American Meteorological society Jan. 1998
9. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo. "*Introduction to wavelets and wavelet transforms*." Prentice Hall Inc. 1997
10. Paul S. Addison, –*The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance*.‖ CRC press, 2002

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC102	**Optical Communication Network**	**03**

Course Pre-requisite:

- Wave theory and Propagation
- Analog Communication
- Digital Communication

Course Objectives:
To teach students:

- The issues related to signal degradation due to Linear Impairments
- System impairments due to nonlinear effect in fiber.
- System optimization by controlling dispersion and Nonlinear Effects.
- High data rate WDM optical Transport Networks.

Course Outcome:

The course enables the students to:

- Apply the fundamental principles of optics and light wave to design optical fiber communication systems.
- Identify the issues related to signal degradation due to multiplexing.
- Identify working principle of various components of all optical network.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.

Module	Detailed Content	Hours
1	**A Review of Optical Fibers** • Introduction • Signal Degradation • Fiber dispersion • Multimode fiber • Single mode fiber • Dispersion Management • Dispersion compensating Fibers	06
2	**Non Linear Optics** • General Overview of Nonlinearities • Effective area and length • Stimulated Raman Scattering • Stimulated Brillouin Scattering • Self Phase modulation	8

	• Cross –Phase modulation • Four wave mixing and its mitigation • Applications of Nonlinear Effects • Solitons properties of Solitons, Properties of Solitons, Loss managed Soliton ,Dispersion managed Soliton, Optical Switching, Parametric amplification	
3	**Optical Network Components** • Sources: Quantum well lasers, Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers • Detectors: Resonant cavity enhancement (RCE) Photo Detector, Material requirement for RCEPD, Wavelength selectivity, High speed comparison of conventional and RCEPD, RCE Schottky Photodiode, RCE Avalanche Photodiode • Optical Amplifiers: Optical Pumping, Erbium Doped Amplifier, Semiconductor Laser Amplifier, Raman Amplifier, • Integrated Optics: Directional couplers and Photonic Switch, Optical Modulators • WDM network components: WADM, Optical Crossconnects	8
4	**Introduction to Optical Network** • Overview of generations of optical Networks • SONET& SDH: Multiplexing hierarchy, Multiplexing structure – Functional components, Problem detection, Virtual tributaries & containers • Optical Transport Network: Hierarchy, Frame structure, Multiplexing	05
5	**WDM Network Design** • Cost Trade-offs: A detailed Ring Network example • LTD and RWA Problems • Routing and Wavelength assignment • Dimensioning wavelength networks • Statistical wavelength routing networks- First passage model, Blocking model • Maximum load dimensioning models- offline lightpath request, online RWA in Rings	06
6	**Deployment Consideration** • Architectural choices for next generation transport Network • Designing the transmission Layer using SDM,TDM and WDM • Unidirectional versus bidirectional WDM Systems- Long haul networks case study, Long Haul Undersea Networks • Metro Networks, Metro Ring Case study	06
	Total	39

Textbooks and References:

1. –*Optical Fiber Communications*‖-Gerd Keiser-Fourth Edition-TATA McGRAW
2. –*Optical Fiber Communications Principles and Practice*‖-John.M.Senior-Pearson Education HILL
3. –*Fiber Optics Communication System*‖-G.P.Agarwal-Wiley Publications
4. –*Fiber Optics Communications*‖- Harold Kolimbris-Pearson Education
5. –*Opto-Electronics, an introduction*‖-Wilson and Hawkes,Prentice Hall
6. –*Nonlinear Fiber Optics*‖ G.P.Agarwal-Academic Press
7. ― *Applications of Nonlinear Optics*‖, Academic press-G.P. Agarwal
8. –*Optical Networks, A Practical Perspective*‖, Third edition- Rajiv Ramaswami, Kumar N. Sivarajan, Elsevier
9. *"Optical Networks, Third generation Transport Systems*‖,by Uyless Black, Pearson
10. –*Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink*‖ by Le Nguyen Binh, CRC Press, 2010

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1011	**Next Generation Networks**	**03**

Course Pre-requisite:

- Computer Networks
- Wireless Networks
- Mobile Communication

Course Objectives:

The aim of this course is

- To relate the paradigm shift from circuit switched network to packet switched network.
- To apply the advancement in networks field.
- To examine new technologies in telecommunication.
- To appraise the NGN Standards

Course Outcome:

Learners will be able to:

- Relate and compare the core differences between traditional and new telecommunication technologies.
- Analyze, implement and apply the components of NGN architecture with NGN standards.

Module	Detailed Content	Hours
1	**Next Generation Technologies, Networks and Services** • Introduction, • Next Generation (NG) Technologies, • Wire line NG Technologies, • FTTP, Long-Haul Managed Ethernet.	06
2	**Wireless NG Technologies** • Long Term Evolution (LTE), • Enhanced HSPA Evolution Data Optimized (EVDO), Ultra Mobile Broadband (UMB), • SDR and cognitive radio • IoT, VOIP, IPTV, Quality of Services, Quality of Experiences in NGN.	7
3	**Next Generation Multiservice Technology Overview** • MPLS &QoS, MPLS services and components, overview of VPN, layer2 VPN, layer 3 VPN	06

4	**ITU NGN Standards and Architectures** • Main drivers to Next Generation Networks – NGN , ITU NGN standards • All-IP network concept for NGN , • NGN control architectures and protocols(TISPAN),Numbering, naming and addressing for all NGN	06
5	**Control and Signalling Protocols for NGN** (SIP, Diameter) • NGN security(AAA, identity management) , • Service convergence • Fixed-Mobile Convergence (FMC) in NGN, • IP Multimedia Subsystem (IMS) for NGN	07
6	**Transition to NGN and Future Evolution** • Migration of PSTN networks to NGN , • Transition of IP networks to NGN, • IPv6, NGN Evolution.	07
	Total	39

Textbooks and References:

Textbooks:

1. *Wireless communication and Networking*-Vijay Garg, ELSEVIER Inc.
2. Next Generation Telecommunications Network, Parliament office of Science and Technology (Postnote). Dec 2007, No. 296 Ref. www.parliament.uk.

Reference Books

1. ITU Manual
2. *Next Generation Telecommunications Networks, Services, and Management* by Thomas Plevyak, VeliSahin, ISBN: 978-0-470-57528-4 , Wiley-IEEE Press
3. *Next Generation Wireless Systems and Networks:* Hsiao – Hwa Chen, Mohsen Guizani – Wiley
4. *IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols*- Jyh- Cheng Chenand Tao Zhang- Wiley

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1012	**Advanced Antenna Design**	**03**

Course Pre-requisite:

- Wave Theory and Propagation
- RF and Antenna

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in microstrip antennas,
- To explain various methodologies presently prevalent for design of microstrip antennas
- To enable students to make design decisions in microstrip antennas

Course Outcome:

Learners will be able to:

- Design and analyze microstrip antennas,
- Correlate the fundamental design of antenna to advanced communication applications

Module	Detailed Content	Hours
1	**Review of Antennas** • Antenna parameters • Infinitesimal dipole antenna • Half wave dipole antenna	03
2	**Microstrip Antennas** • Introduction, Rectangular patch and Circular patch design • Quality factor, Bandwidth, Efficiency, Input impedance, and Coupling • Analytical models for MSAs transmission line models, cavity model, Multimode network model.	6

3	**Circular Polarization Technique** • Dual-Feed circularly polarized MSAs, Square MSA with two feeds, Effect of amplitude and phase imbalance, Square MSA with four feeds, CMSA with multiple feeds • Single-feed circularly polarized MSA, Diagonally fed nearly square MSA, Square MSA with modified edges, Square MSA with modified corners, Square MSA with a diagonal slot. • Broadband circularly polarized MSA, Dual-feed planar multiresonator MSA, Stacked MSA for circular polarization, Aperture coupled circularly polarized MSA, Sequentially rotated MSA.	7
4	**Planar Monopole Antennas**	7
	• Introduction, Planar Rectangular and Square Monopole Antennas, RMSA Suspended in Air with Orthogonal Ground Plane, Calculation of the Lower Frequency of the Planar Monopole Antennas. • Effect of Various Parameters of Planar Rectangular Monopole (RM) Antennas, Radiation Pattern of RM Antennas • Various Planar RMs with Equal Areas, Planar Circular Monopole Antennas.	
5	**Broadband and Compact Microstrip Antennas** • Mechanism of Parasitic Coupling for Broad BW, Gap-Coupled RMSAs, Radiating-Edge Gap-Coupled RMSAs, Multilayer Broadband MSA, Design Examples. • Compact Shorted RMSAs, Partially Shorted RMSAs, Effect of Dimensions of RMSAs with a Single Shorting Post, Effect of the Position of the Single Shorting Post	08
6	**Next generation Antennas** • Introduction to smart antennas, smart Antenna configurations-switched beam antennas and adaptive antenna approach, Smart Antennas‘ Benefits and draw backs, Antenna Beam forming, Architecture of Smart antenna system. • Metamaterial Antennas: Introduction, Negative Refractive Index (NRI) Metamaterials, Metamaterial Antennas Based on NRI concepts. • Applications of Smart Antennas: Smart antennas for Code Division Multiple Access Systems, Smart antennas for automatic radio frequency identification readers, Mutual coupling reduction techniques in MIMO.	08
	Total	39

Textbooks and References:

1. *Antenna Theory*- C. A. Balanis- Wiley and sons
2. *Antennas* – John. D. Krauss- TMH ed.
3. *Microstrip Antenna Design Handbook* - Ramesh Garg- Artech House.
4. *Handbook of Microstrip Antennas* - James R. James, Peter S. Hall-IEE Electromagnetic wave series.
5. *Broadband Microstrip antennas* – Girish Kumar and K.P. Ray, Artech House
6. *Smart Antennas for Wireless Communications with MATLAB*: Frank Gross, McGRAW Hill.
7. *Handbook on Advancements in Smart Antenna Technologies for Wireless Networks*- Chen Sun, Jun Cheng and Takashi Ohira, Information science reference, New York.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1013	**Statistical Signal Processing**	**03**

Course Pre-requisite:

- Matrix theory
- Fundamentals of probability
- Signals and systems

Course Objectives:

The aim of this course is to provide knowledge of statistical techniques necessary to explain and explore the important applications in signal processing and telecommunication.

Course Outcome:

Learner will be able to:

- Understand basics of linear algebra in communication engineering.
- Apply appropriate statistical tools for handling design and analysis of systems that involve randomness.
- Analyze random processes for LTI systems and estimation theory.
- Evaluate role of probability models in engineering design.

Module	**Detailed Content**	**Hours**

1	**Linear Algebra** • Signal spaces, metric spaces, vector spaces, norms and normed vector spaces, inner-product spaces, orthogonality, orthogonal subspaces, linear transformations: range and null space, orthogonalization of vectors, representation and approximation in vector spaces, matrix representation of least squares, geometry of linear equations, four fundamental subspaces of linear operator, properties of matrix inverses, results on matrix rank, pseudo inverses, matrix condition number, singular value decomposition(SVD), pseudoinverse and the SVD.	8
2	**Review of Random Variables and Processes** • Random variables, distribution and density function, functions of random variables, sums of independent random variables, central limit theorem, discrete time stochastic process, stationarity, random signal variability, time averages, ergodicity, autocorrelation function of a real WSS process and its properties, cross-correlation function, frequency domain description of stationary process, general correlation matrices, correlation matrices from random process, correlation matrices of stationary process.	07
3	**Analysis and processing of random signals** • Linear time invariant system with WSS process as an input stationarity of the output, auto-correlation and power-spectral density of the output; examples with white-noise as input; linear shift-invariant discrete-time system with WSS sequence as input, examples of random processes: white noise process and white noise sequence; Gaussian process.	04
4	**Whitening and Innovations Representation** • Transformations using eigen-decomposition, transformations using triangular decomposition, generation of real valued random vectors with given second-order moments, discrete Karhunen-Loève transform and its application, optimal reduced-basis representation, periodic random sequences.	07
5	**Principles of Estimation Theory** • Estimation in signal processing, the mathematical estimation problem, assessing estimator performance, unbiased and consistent estimators, confidence interval, efficient estimator, minimum variance unbiased estimation, existence of minimum variance unbiased estimator, estimator accuracy considerations, Cramer-Rao lower bound(CRLB) theorem, computation of CRLB for different examples, general CRLB for signals in white-Gaussian noise, vector parameter CRLB.	7

6	**The Kalman Filter** • The state space signal model, Kalman filter I: The Bayes approach, Kalman filter II: innovations approach, Estimation using the innovations process, innovations for processes with state space models. Discrete-time Kalman filter.	06
	Total	39

Textbooks and References:

1. Todd K. Moon and Wynn C. Stirling, –*Mathematical Methods and Algorithms for Signal Processing*‖, Pearson Education, Inc., 2000.
2. Dimitris. G. Manolakis, Vinay Ingale, and Stephen M. Kogon, –*Statistical and Adaptive Signal Processing*‖, Artech House, Inc., 2005.
3. Peyton Z. Peebles, –*Probability, Random Variables and Random Signal Principles*‖, Mc-Graw Hill, 2000.
4. Steven M. Kay, –*Fundamentals of Statistical Signal Processing: Estimation Theory* Vol 1, Prentice Hall, Englewood Cliffs, NJ, 2010.
5. Alberto Leon-Garcia, –*Probability and Random Processes for Electrical Engineering*‖, Pearson Education, 2007.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETPE1021	**Image Analysis using Machine learning**	**03**

Course Pre-requisite:

- Image and Video processing

Course Objectives:

The aim of this course is

- To provide exposure to students in gaining knowledge on concepts and understanding of Image Analysis.
- To give necessary knowledge of digital image analysis for further research within the area and to be able to use digital image analysis within other research areas such as computer graphics, image coding, video coding and industrial image processing problems.
- To prepare the student for further studies in e.g. computer vision, multispectral image analysis and statistical image analysis.

Course Outcome:

Learners will be able to:

- Demonstrate good capability to independently identify problems which can be solved with methods from image analysis, and be able to choose an appropriate method.
- Independently apply basic methods in image processing to problems which are relevant in industrial applications or research.
- Explain the solution to a problem in image analysis in a well structured manner and with clear logic.

Module	Detailed Content	Hours
1	**Introduction to Image Processing** • Basic mathematical concepts: Image transforms, Discrete Fourier Transform, Fast Fourier Transform. • Image enhancement: Grey level transforms, filtering. Extraction of special features: Filtering, edge and corner detection. Image Segmentation and mathematical morphology.	05
2	**Image Representation** • Boundary Representation: Chain Code, Polygonal Approximations, Signatures, Bending Energy, Statistical Moments, Region Representation • Boundary Descriptions: Simple Descriptor, Shape Number, Fourier Descriptor, Run-length Code, Projection, Concavity Tree.	06
	• Component Labelling: Component counting, Recursive Algorithm, Sequential Algorithm.	
3	**Feature Extraction** • Histogram (or Brightness) Features, Shape Features, Spatial Moment, Central Moment, Topological Features, Geometrical Features, Transform Features, Texture Features, Syntactic and Structural Features	07
4	**Evaluating Hypotheses** • Estimating Hypothesis Accuracy, Basics of Sampling Theory, Deriving confidence intervals, difference in error of two hypotheses, Comparing Learning Algorithms.	06
5	**Learning Algorithms** • Decision Tree Learning : Building Single and Multiple Decision Trees Selecting the Decision Tree to be Built, Obtaining Prules from Decision Trees, Missing Attribute Values, Classifying with Relabelled Nodes, Error Rates on Recall Sets, Pruning Decision Trees, Issues in decision tree learning. • Bayes Learning : Bayes Theorem and concept learning, Bayesian Belief Networks, Naive Bayes with Binary Attributes, Performance of Bayes Classifier • Instance Based Leaning : K-nearest neighbour learning, case based learning, radial basis functions • Deep Learning Algorithm : Deep Networks, Deep Belief Networks, Convolutional Networks,	07

6	**Image Classification** Image Classification using - Neural network: Issues in neural network learning, perceptrons, multilayer network & Back propagation Algorithm. - Fuzzy Systems: Fuzzy logic, Fuzzification, Fuzzy inference, fuzzy rule based system, defuzzification - Support Vector Machine : Linear Classifiers, Classifier Margin, Solving the Optimization Problem, Hard Margin and Soft Margin, Linear and Non Linear SVMs, Kernel functions, - Genetic Algorithms : Genetic operators, genetic programming, models of evolution & learning, parallelizing genetic algorithm	8
	Total	39

Textbooks and References:

Textbooks:

1. Mitchell, Tom. *Machine Learning*. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
2. Haykin, Simon S. Neural Networks and Learning Machines, 3rd edition Pearson 2008.
3. Sonka, Milan. Hlavac Vaclav. Boyle Roger. *Image Processing, Analysis and Machine Vision*, New Delhi: Thomson Learning, 2001. ISBN: 9812400613.
4. Rajasekaran S, Vijaylakshmi Pai G.A. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Application. New Delhi, Prentice Hall of India.
5. Valluru, Sudarshan K. Rao Nageswara T., Introduction to Neural Networks, Fuzzy Logic & Genetic algorithms, Jaico Publishing House 2010.

Reference Books:

1. Bishop, Christopher. *Pattern recognition and machine learning*, Springer Verlag, 2006.
2. Shinghal Rajjan, Pattern Recognition Techniques and Applications. New Delhi Oxford University Press, 2011. ISBN 9780195676853.
3. Richards John, Jia Xiuping, *Remote Sensing Digital Image Analysis*, Springer 2006. ISBN : 9783540251286

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits

ETDLO1014	Embedded Communication System Design	04

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To impart the concepts and architecture of embedded systems and to make the students capable of designing embedded systems product.
- To achieve this, system design, architecture and programming of industry popular ARM Cortex is covered in detail.

Course Outcome:

Learners will be able to:

- Understand the embedded concepts and architecture of embedded systems
- Understand the architecture and programming of ARM Cortex microcontroller
- Understand the open source RTOS and their usage
- Able to design an embedded systems application
- Able to usage of the development and debugging tools

Module	Detailed Content	Hours
1	**Overview of Product Design** • Need, design challenges, product survey, specifications of product need of hardware and software, partitioning of the design into its software and hardware components, iteration and refinement of the partitioning.	06
2	**Software and Hardware** • Tradeoffs, custom single-purpose processors, general-purpose processors, memory, interfacing, design technology-hardware design, cost reduction, re-engineering, optimization, maintenance, validation and development, prototyping, turnkey product design.	06
3	**Embedded Systems and ARM Architecture** • Embedded concepts, architecture of embedded systems, ARM architecture, Cortex-M3 basics, exceptions, instruction sets, NVIC, interrupt behavior, Cortex-M3/M4 programming, memory protection unit and other Cortex-M3 features, STM32xxx ARM Cortex M3/M4 microcontroller memory and peripherals, development & debugging tools.	8
4	**Communication and Security** • Embedded systems security and secured hardware structures. Communications security in embedded systems.	04

	Embedded systems time constraints	

5	**Multi core Architecture** • Multi-Core architecture for embedded systems, Programming models for Multi-Core, Embedded Multi-Core processing for networking.	04
6	**Open Source RTOS** • Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matric in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues –selecting a Real Time Operating System, RTOS comparative study. • Interfacing Modules: Sensor and actuator interface, data transfer and control, GPS, GSM, Bluetooth,	11
	Total	39

Textbooks and References:

1. *The Definitive Guide to the ARM Cortex-M3,* Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *"ARM System Developer's Guide -Designing and Optimizing System Software",* 2006, Elsevier.
3. *Communicating Embedded Systems: Networks Applications,* Francine Krief (Editor) February 2010, Wiley-ISTE
4. Frank Vahid and Tony Givargis, *"Embedded System Design: A Unified Hardware/Software Introduction",* John Wiley publication
5. P Marwedel, *"Embedded System Design",* Springer publication
6. Christopher Hallinan, *"Embedded Linux Primer: A Practical Real-World Approach* Second Edition, Pearson Education Publication

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted

bject Code	Subject Name	Credits
ETPE1023	**Optimization Methods in Signal Processing for Communication**	**03**

	Systems	

Course Pre-requisite:

- Linear Algebra

Course Objectives:

The aim of this course is

1. To develop understanding of fundamental linear algebra concepts, geometrical concepts, and basic calculus which are essential for optimization course.
2. To develop understanding of formulating a typical unconstrained and constrained optimization problem.
3. To develop understanding of types of convex optimization problems such as linear programming, geometric programming, quadratic programming, second-order cone programming, and semi definite programming.
4. To develop understanding of Lagrange's duality concepts and interior-point methods for convex optimization problems.

Course Outcomes:

Learners will be able to:

1. Apply the concepts of linear algebra for modeling research problems in the field of communications and signal processing.
2. Identify the appropriate convex optimization problem for modeling typical research problems in the field of communications and signal processing.
3. Develop algorithms for modern wireless communications and networking, e.g., optimal resource allocation, energy efficiency maximization, sum-rate maximization, optimal beam forming, etc.
4. Model and analyze the research problems for 5G and beyond wireless networks, e.g., massive MIMO networks, mm Wave networks, energy harvesting networks, UAV networks, etc.
5. Apply the optimization theory for typical signal processing applications, e.g., blind source separation for biomedica and hyper spectral image analysis, filter design, etc.

Module No.	Topics	Hrs.
1.0	**Fundamentals of Geometry and Calculus**	**08**

	Geometrical Concepts: Lines and line segments, Affine sets and affine hull, Convex sets and convex hull, Cone and conic hull, Hyper planes and half spaces, Neighborhood (Euclidean ball) and ellipsoid, Interior point, Boundary point, Open and closed sets, Boundary set, Compact set, Polyhedra, Separating and supporting hyper planes, Basics of Calculus: Sequences and limits, Affine functions, Differentiability, Derivative matrix, Hessian, Level sets and gradients, Graph, Taylor's series, Mean value theorem.	
2.0	**Introduction to Optimization**	**08**
	1) Basics of an optimization problem, Conditions for local minimizers: First order necessary condition (FONC), Second order necessary condition (SONC), Second order sufficient condition (SOSC). 2) Unconstrained Optimization Algorithms: One dimensional search algorithms: Exhaustive search, Golden section method, Fibonacci method, Bisection method, Newton's method, Secant method, Bracketing, Gradient methods: Gradient descent algorithm, Steepest descent method, Newton's method (revisited): Levenberg-Marquardt modification, Conjugate direction and gradient algorithms.	
3.0	**Convex Optimization-I**	**4**
	Convex and quasi-convex functions, Convexity preserving operations, Basic structure of convex optimization problems, Equivalent representations and transforms, Convex problems with inequality constraints.	
4.0	**CONVEX OPTIMIZATION -II**	**07**
	Linear Programming: Standard form of linear program (LP), Transformation to standard form using surplus and slack variables, Geometry of LP, Basic solutions, Fundamental theorem of LP, Graphical solution, Simplex method: Canonical augmented matrix, Updating procedure for augmented matrix, Simplex algorithm, Matrix form of Simplex method, Two-phase Simplex method, Dual LP, Non-simplex methods, Integer linear programming.	
5.0	**Convex Optimization-III**	**05**
	1) Second-order cone programming (SOCP), Semidefinite Programming (SDP): QCQP and SOCP as SDP via Schur complement, S-procedure. 2) Duality: Lagrange dual function and conjugate function, Lagrange dual problems, Strong duality: Slater's condition, S-Lemma, Karush-Kuhn-Tucker (KKT) optimality conditions.	
6.0	**Optimization Techniques**	**07**

	1) Lagrange dual optimization, Alternating direction method of multipliers (ADMM), Duality of problems with generalized inequalities, Theorems of alternatives. 2) Interior-point Methods: Inequality and equality constrained convex problems, Newton's method and barrier function, Central path, Barrier method, Primal-dual interior point method.		
		TOTAL	**39**

ESSENTIAL READING

1. C. -Y. Chi, W. -C. Li, and C. -H. Lin, Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications, CRC Press , 1st Edition, 2017
2. E. K. P. Chong, and S. H. Zak, An Introduction to Optimization, Wiley , 4th Edition, 2013

SUPPLEMENTARY READING

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press , 1st Edition, 2004
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Learning , 4th Edition, 2006

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ETIE1011	**Product Life Cycle management**	**03**

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course Outcome:

Learners will be able to:

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Content	Hours
1	**Introduction to Product Lifecycle Management (PLM)** • Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies** • Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM.	10
2	**Product Design** • Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic	09

	Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3	**Product Data Management** • Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
4	**Virtual Product Development Tools** • For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
5	**Integration of Environmental Aspects in Product Design** • Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
6	**Life Cycle Assessment and Life Cycle Cost Analysis** • Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Textbooks and References:

1. John Stark, –*Product Lifecycle Management: Paradigm for 21st Century Product Realisation*‖, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, –*Product Design for the environment-A life cycle approach*‖, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, –*Product Life Cycle Management*‖, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, –*Product Lifecycle Management: Driving the next generation of lean thinking*‖, Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ETIE1012	**Reliability Engineering**	**03**

Course Objectives:

The aim of this course is

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcome:

Learners will be able to:

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Content	Hours
1	**Probability theory** • Probability: Standard definitions and concepts; Conditional Probability, Baye‘s Theorem. **Probability Distributions** • Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion** • Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08

2	**Reliability Concepts** • Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis** • Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models** • Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
3	**System Reliability** • System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	**Reliability Improvement** • Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. • System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
5	**Maintainability and Availability** • System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. • Availability – qualitative aspects.	05
6	**Failure Mode, Effects and Criticality Analysis** • Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Textbooks and References:

1. L.S. Srinath, ―*Reliability Engineering*‖, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, ―*Reliability and Maintainability Engineering*‖, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, ―*Engineering Reliability*‖, John Wiley & Sons, 1980.
4. P.D.T. Conor, ―*Practical Reliability Engg*.‖, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, ―*Reliability in Engineering Design*‖, John Wiley & Sons.

6. Murray R. Spiegel, ―*Probability and Statistics*‖, Tata McGraw-Hill Publishing Co. Ltd.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Subject Code	Subject Name	Credits
ILO1013	**Management Information System**	**03**

Course Objectives:

The aim of this course is

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today‘s business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Course Outcome:

Learners will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Content	Hours
1	**Introduction To Information Systems (IS)** • Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	04
2	**Data and Knowledge Management** • Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. **Business intelligence (BI)** • Managers and Decision Making, BI for Data analysis and Presenting Results	07
3	**Ethical issues and Privacy** • Information Security, Threat to IS, and Security Controls	07
4	**Social Computing (SC)** • Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	07
5	**Computer Networks:**	06

	• Wired and Wireless technology, Pervasive computing, Cloud computing model.	
6	**Information System within Organization** • Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. • Acquiring Information Systems and Applications: Various System development life cycle models.	08

Textbooks and References:

1. Kelly Rainer, Brad Prince, *Management Information Systems,* Wiley
2. K.C. Laudon and J.P. Laudon, *Management Information Systems: Managing the Digital Firm*, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, *Managing Information Systems: Strategy and Organization*, Prentice Hall, 2008

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by

Course Code	Course Name	Credits
ETIE1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, ―Taguchi Technique for Quality Engineering,‖ McGrawHill
7. Madhav S Phadke, ― Quality Engineering using Robust Design,‖ Prentice Hall

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1015	**Operations Research**	**03**

Course Objectives:
The aim of this course is

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Course Outcome:
Learners will be able to:

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model‘s optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.

  Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Content	Hours
1	**Introduction to Operations Research** • Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming** • Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem** • Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel‘s approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem** • Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines	14

	Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem** - Introduction, Types of Integer Programming Problems, Gomory‘s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2	**Queuing models** - Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
3	**Simulation** - Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
4	**Dynamic programming** - Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
5	**Game Theory** - Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
6	**Inventory Models** - Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Textbooks and References:

1. Taha, H.A. "*Operations Research - An Introduction*", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "*Operations Research: Principles and Practice*", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "*Introduction to Operations Research*", Tata McGraw Hill, 2002.
4. *Operations Research,* S. D. Sharma, KedarNath Ram Nath-Meerut.
5. *Operations Research,* KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

ject Code	Subject Name	Credits
ETIE1016	**Cyber Security and Laws**	**03**

Course Objectives:
The aim of this course is

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Course Outcome:
Learners will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Content	Hours
1	**Introduction to Cybercrime** • Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	04
2	**Cyber offenses & Cybercrime** • How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in • Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	09
3	**Tools and Methods Used in Cyberline** • Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	06
4	**The Concept of Cyberspace** • E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber	08

	Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
5	**Indian IT Act.** • Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	06
6	**Information Security Standard compliances** • SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	06

Textbooks and References:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi.
2. *The Indian Cyber Law* by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. *The Information technology Act*, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. *Cyber Law & Cyber Crimes* By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security* & *Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1017	**Disaster management and Mitigation Measures**	**03**

Course Objectives:

The aim of this course is

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Course Outcome:

Learners will be able to:

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do‘s and don‘ts in such extreme events and act accordingly.

Module	Detailed Content	Hours
1	**Introduction** • Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** • Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion • Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** • Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	• Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4	**Institutional Framework for Disaster Management in India:** • Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. • Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
5	**Financing Relief Measures:** • Ways to raise finance for relief expenditure, role of government agencies and NGO‘s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO‘s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. • International relief aid agencies and their role in extreme events.	09
6	**Preventive and Mitigation Measures:** • Pre-disaster, during disaster and post-disaster measures in some events in general • Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication • Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. • Do‘s and don‘ts in case of disasters and effective implementation of relief aids.	06

Textbooks and References:

1. ‗*Disaster Management*‘ by Harsh K.Gupta, Universities Press Publications.
2. ‗*Disaster Management: An Appraisal of Institutional Mechanisms in India*‘ by O.S.Dagur, published by Centre for land warfare studies, New

Delhi, 2011.

3. ‗*Introduction to International Disaster Management*‘ by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. ‗*Disaster Management Handbook'* by Jack Pinkowski, CRC Press Taylor and Francis group.
5. ‗*Disaster management & rehabilitation'* by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‗*Natural Hazards and Disaster Management*, Vulnerability and Mitigation – R B Singh, Rawat Publications

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE1018	**Energy Audit and Management**	**03**

Course Objectives:

The aim of this course is

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcome:

Learners will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Content	Hours
1	**Energy Scenario** • Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles** • Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. • Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08

3	**Energy Management and Energy Conservation in Electrical System** • Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** • Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** • Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. • General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment** • On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	**Energy conservation in Buildings** • Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Textbooks and References:

1. *Handbook of Electrical Installation Practice*, Geofry Stokes, Blackwell Science
2. *Designing with light: Lighting Handbook*, By Anil Valia, Lighting System
3. *Energy Management Handbook*, By W.C. Turner, John Wiley and Sons
4. *Handbook on Energy Audits and Management*, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. *Energy Management Principles*, C.B.Smith, Pergamon Press
6. *Energy Conservation Guidebook*, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. *Handbook of Energy Audits*, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETL101	**Program Lab-I**	**01**

Course Code	Course Name	Examination Scheme			
			Term Work	Practical and Oral	Total
ETL 101	Program Lab-1		25	25	50

Course Objectives:

1. To learn the concept of impedance matching and RF filters
2. To learn Microwave amplifiers, oscillators and mixer

Course Outcomes: Learners will be able to ...

1. Analyze Bio medical signal using simulation software.
2. Analyze the performance of per processing tools using simulation software.

Term Work:

At least 08 experiments covering the entire syllabus must be given −Batch Wise‖. Computation/simulation based experiments are also encouraged. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Sr. No.	Title of Experiment
1	Estimation of Periodogram and Spectrogram and Demonstrate their applications.
2	Pre-processing of Bio-electric signals
3	Wavelet analysis for denoising of Bio-electric signals
4	Wavelet transform for audio signal compression
5	Simulation of adaptive filtering and their applications
6	Generation of Chorus and flanging effects for voice record
7	Implementation of equalizers
8	Simulated generation of ECG signal and isolation of QRS complex
9	Analysis of EEG signals

- Out of 9 Experiments any 8 Experiments have to be performed.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETC201	**RF Engineering**	**03**

Course Pre-requisite:

- Electromagnetics and Antenna
- Microwave Engineering

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in RF circuits and microwave systems.
- To explain various methodologies presently prevalent for design of active and passive RF circuits.
- To enable students to make system level design decisions.
- To expose students to state-of-art simulation systems.
- To teach students Computer aided design tools for analysis and design of circuits

Course Outcomes:

Learners will be able to:

- Characterize devices at higher frequencies.
- Design and analyze RF circuits and components.
- Design and analyze amplifiers, oscillators and mixers at microwave frequencies.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to RF, Impedance Matching and RF Filter**	**08**
	1.1	**Introduction** Characteristics of RF Waves and applications, RF Components and Circuits: Equivalent Circuits of Concentrated Passive Components like Resistors, Capacitors, Inductors.	
	1.2	**RF Filter Design and Implementation:** Butterworth Filter, Chebyshev Filter, Stepped Impedance Filter.	
	1.3	**Analysis and design:** Strip lines, Microstrip lines and coupled lines.	
	1.4	**Impedance Matching:** Causes and effects, Techniques using L-C and distributed Parameters.	
2.0		**Device Characterization**	**06**
	2.1	Multi-port Network representation, S-parameters: Properties and characterization.	
	2.2	Spectrum Analyzer and Vector Network Analyzer Basics	
	2.3	Noise Characterization: Noise Figure, Noise temperature, Noise parameters, Noise Correlation matrix.	
3.0		**Amplifier Design**	**10**
	3.1	Two-port power gains, Stability Determination: Mathematical and Graphical	
	3.2	Single stage amplifier design: Design for Maximum Gain, Design for Specified Gain, Low Noise Amplifier design	
	3.3	Power amplifiers: Characteristics of power amplifier and classes of amplifiers, Design of Class A power amplifier	
4.0		**Frequency Generation and Mixers**	**06**
	4.1	One-port and two-port microwave oscillator design, Analysis of phase noise in oscillators.	
	4.2	Mixers: Characteristics, Types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, and Image reject mixers.	
5.0		**Electromagnetic Interference in RF circuits**	**05**
	5.1	Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits.	
	5.2	Elements Of Interference including Antennas, Transmitters, Receivers and Propagation.	
	5.3	**EMI Coupling**: **Common-Mode Coupling**: Common-Mode Coupling Mechanisms Including Field to Cable, Ground Impedance, Ground Loop and Coupling Reduction Techniques. Differential-Mode Coupling: Differential-Mode Coupling Mechanisms Including Field to Cable, Cable to Cable and Coupling Reduction Techniques.	
	5.4	**Other Coupling mechanisms:** Power Supplies and Victim Amplifiers.	
6.0		**Electromagnetic Compatibility**	**04**
	6.1	The Importance of Grounding for achieving EMC, Grounding	

		Schemes (Single Point, Multi-Point and Hybrid), Shield Grounding and Bonding. Shielding Effectiveness, Shielding Considerations (Reflective and Absorptive), Shielding Compromises (I.E., Apertures, Gaskets, Waveguide Beyond Cut-Off).	
	6.2	**EMC Specifications, Standards and Measurements.** A Review Of MIL-Standards, FCC And CISPR Requirements.	
		Total	**39**

Textbooks and References:

1. David Pozar, –*Microwave Engineering*‖, Wiley Publication, Fourth Edition
2. Matthew M. Radmanesh, –*Radio Frequency and Microwave Electronics*‖, Pearson Education.
3. David Weston F. Giannini, G. Leuzzi, –*Non-linear Microwave Circuit Design*‖, Wiley Publication.
4. David Weston –*Electromagnetic Com*patibility, Principles and Applications‖ Marcel Dekker,Second Edition

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETC202	**Modern Digital Communication**	**03**

Course Pre-requisite:

- Digital communication
- Random Signal Analysis

Course Objectives:

The aim of this course is to let the students obtain

- Fundamentals of modern communication system
- Ability to analyze and design digital communication systems

Course Outcome:

Learners will be able to:

- Explain and implement different source coding techniques
- Analyze waveform receivers for coherent and non-coherent communication
- Describe and design of band-limited channels
- Evaluate the detection and estimation of signals in the presence of noise.
- Explain the characteristics of fading channels.

Module	Detailed Content	Hours
1	**Source Coding** • Average ,mutual information & entropy • Coding for discrete sources • The Lempel algorithm(LZ-77,LZ-78,LZW) • Coding for analog sources -Temporal waveform coding • Spatial waveform coding	06

2	**Coherent Communication with Waveforms** - Binary cross-correlation receivers - Matched filter receivers - M-ary waveform receivers - Time-sampling approach - Karhunen-Loeve(K-L) Expansion approach - Whitening approach - Real and complex signal models - Effect of Data Imperfect Carrier Synchronization - Effect of Data Imperfect bit synchronization	07
3	**Non Coherent Communication with Waveforms** - Non Coherent receivers in random phase channels - Optimum M-FSK receivers - Non coherent receivers in random amplitude and phase channels - Optimum receivers in Rayleigh channels - Optimum receivers in Rician channels	07
4	**Signal Design for Channel and Equalization** - Design of band limited signals with controlled ISI - Symbol by symbol sub optimum detection - Introduction to linear equalizer - Means square error (MSE) criterion - Iterative equalization and decoding - Introduction to adaptive equalization - The LMS Algorithm	07
5	**Optimum Detection and Estimation** - Noise vector in signal space - Bayes detection of received signal - Decision region & minimum error probability - Optimum detection of several special comm. signals	06
6	**Fading Channels** - Small scale multipath propagation - Parameters of mobile multipath channels - Types of small scale fading - Rayleigh and Rician distribution	06
	Total	39

Textbooks and References:

1. *Digital Communication* by John G.Proakis, 3rd Edition McGraw –Hill International Editions.
2. *Digital Communication Techniques Signal Design & Detection* by Marvin K. Simon, Sami M Hindei, William C Lindesy, PHI Learning Private Limited.
3. *Digital Communications, Fundamental & Application* by Bernard Sklar,

Pabitra Kumar Ray, 2nd Edition , Pearson Publication

4. *Wireless communication principles and practice* by Theodore S. Rappaport, 2nd Edition , Pearson Publication

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2011	**Satellite Networking**	**04**

Course Pre-requisite:

- Satellite Communication and Networks
- Internet Voice and Mobile Communication

Course Objectives:

The aim of this course is

- To understand and learn advanced networking techniques with satellite systems
- To be able to devise link budget model of satellite communication for specific applications
- To be able to apply knowledge to upgrade satellite communication systems

Course Outcome:

Learners will be able to:

- Perform link budget for specific satellite application
- Learn different advanced satellite networking concepts
- Understand usage of lasers in satellites and satellite service applications

Module	Detailed Content	Hours
1	**Introduction** • Origin of satellite communications, Development, space and ground segments, types of orbits, evolution of satellite communication, Development of satellite services and Launching mechanism in the Geostationary orbit, Orbits and orbital perturbations	08
2	**System Segment and Link Analysis** • AOCS, TTC, Equipment Reliability and Space qualifications, Link analysis	06
3	**Satellite Networks Architecture and organization** • Applications and services of satellite network, network reference models, Architecture, On board connectivity, frame organisation, Window organization	06
4	**Laser Satellite Communications** • Link introduction, optical satellite link transmitter, Receiver, satellite beam acquisition, Tracking and positioning, Single hop satellite connections, multi hop satellite connections, inter satellite links	07
5	**Specific Satellite Network** • Study of IRIDIUM and GLOBALSTAR Synchronous Digital Hierarchy (SDH), Integrated services digital networks (ISDN),	06

	ISDN over satellite, Interworking with heterogeneous networks, Case studies - satellite image analysis and photogrammetry.	
6	**Satellite Applications** • Communication applications (ATM service, DTH service, TV broadcast), Earth observation applications (Urban planning, Oceanography, resource management, agriculture services), Meteorology applications weather forecasting,	06
	Total	39

Textbooks and References:

1. *Satellite Communication Systems, Techniques and Technology* -5th Edition by Gerard Maral and Michel Bousquet, John Wiley Publication (Text book for chapter-1 to 5)
2. *Mobile Satellite Communication Networks* – By Ray Sheriff, Y. Fun Hu, John Wiley Publication (Text book for chapter-1 to 3)
3. *Satellite Networking: Principles and Protocols* 2nd Edition by Zhili Sun, John Wiley Publication (Text book for chapter-3 & 5)
4. *Satellite Communications* by Roddy Dennis, 5th Edition, McGraw Hill Education Publication (Reference book)
5. *Satellite Communication* – Timothy Pratt, C. Boustian, J. Allmuti, Wiley Publication (Reference Book)

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETDLO2022	**Network and Cyber Security**	**04**

Course Pre-requisite:

- Computer Communication Networks
- Operating System
- Probability Theory and Random Processes

Course Objectives:

The aim of this course is

- To introduce advanced techniques to implement security mechanisms using IDS, Firewall, and Antivirus and Biometrics, Incident handling and Forensics
- To discuss security implications on Organizations, security standards and Cyber laws.

Course Outcome:

Learners will be able to:

- Describe security threats and apply security techniques using cryptosystems.
- Explain the key terms and concepts in cyber law, intellectual property and cyber crimes, trademarks and domain theft
- Build and configure firewall and intrusion detections systems‘ using GNU open source security tools.
- Incorporate approaches for incident analysis and response, for risk management and best practices and digital evidence collection, and evidentiary reporting in forensic acquisition

Module	Detailed Content	Hours
1	**Introduction to Network and Cyber Security** • Need for network security, Attacks and Their classification, • Network Vulnerabilities and control • Security services and mechanisms, • Impact of Security on Enterprises • Risk Factors and Cost Analysis.	04
2	**Cryptography and Cryptosystems** • Classical and modern cryptography, stream and block ciphers, • Message digest, digital signature, digital certificate, certificate authority, cryptanalysis • DES/AES/RSA/RC4/MD5/SHA algorithms • Secure protocols SSL, IPSec, VPN,PKI	7
3	**Ethical Hacking and Network Differences**	8

	• Cybercrimes, Cybercriminals, Cyberoffences, Cybercrimes in Mobile and Wireless Devices, Tools and Methods used in Cybercrimes • Network reconnaissance, scanning and sniffing, gaining access. • Security Technologies: Firewall, IDS and Antivirus, Reverse proxy • L7 content filtering firewall, NAT & reverse proxy, Firewall deployment and limitations, selection of firewalls. Performance analysis of firewall. • Signature and Anamoly based IDSs, IDS deployment, zone diagram, performance analysis of IDS, strengths and limitations of IDS	
4	**Cybersecurity Principles and best Practices** • Layered Defense, Surveillance and Reconnaissance Outsider/Internal Threat Protection, • Privacy, Intellectual Property, Professional Ethics, Freedom of Speech, Fair User and Ethical Hacking, Trademarks ,Internet Fraud ,Electronic Evidence.	6
5	**Cybersecurity Implications on Organizations, Standards and Cyber laws** • Risk Management: Asset Evaluation and Business Impact Analysis, Risk Identification, Risk Quantification, Risk Response Development and Control Security Policy, Compliance, and Business Continuity. • Cyber Incident Preparation: Incident Detection and Analysis, Containment, Eradication, and Recovery ,Proactive and Post-Incident Cyber Services • Forensics: Forensic Technologies ,Digital Evidence Collection ,Evidentiary Reporting • The Indian IT Act and new amendments.	8
6	**System Security and Case Study** • Security Operations Center (SOC), Network Operations Center (NOC), • Network Security Audit • SET, Biometric Security, Digital Immune System • Cloud Security. Wi-Fi Security, Mobile and Cellular Security.	6

Textbooks and References:

1. *Cryptography and Network Security* by Behrouz Forouzan McGrawHill Publications
2. *Security in Computing* by Pfleeger and Pfleeger, Pearson Publications
3. *Management of Information Security* by M. Whitman Cengage Publications
4. Cengage Learning India, *Network Security and Cryptography* by B. Menezes.

5. *Computer Security* by Matt Bishop, Pearson Publication
6. *Cryptography and Network Security* by William Stallings, Pearson publications.
7. *Cyber Security* by Nina Godbole, John Wiley Publications
8. *Information Security: Principles and Practice,* 2nd edition by Mark Stamp and Deven Shah.
9. *Data Communication & Network Security* by Houston Carr and Charles Snyder, McGraw-Hill Publication.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2013	**Remote Sensing**	**03**

Course Pre-requisite:
- Digital Image Processing

Course Objectives:
The aim of this course is
- To provide exposure to students in gaining knowledge on concepts and applications of Remote Sensing
- To give exposure to participants for Digital Image Processing with more emphasis on classification
- To acquire skills in advance techniques such as hyper spectral, thermal and microwave for mapping and monitoring.

Course Outcome:
Learners will be able to:
- Demonstrate detailed, integrated knowledge of the application and history of remote sensing
- Discuss the nature of electromagnetic radiation and its interaction with the earth's surface and atmosphere
- Demonstrate a critical understanding of the differences between remote sensing systems and be aware of their characteristics and limitations
- Critically identify specific applications where remote processing may be used as a tool for monitoring and research.

Module	Detailed Content	Hours

1	**Introduction to Remote Sensing** • What is Remote Sensing (RS)? Characteristics/elements of RS systems, Electromagnetic Radiation Electromagnetic Spectrum, Polarization, Interactions with the Atmosphere (Absorption, Scattering: Rayleigh, Mie, Non selective, absorption), Radiation - Target interactions, Passive vs. Active Sensing, Basic Image processing concepts: Image as a matrix, B/W and Colour (RGB)	06
2	**Sensors** • Ground and Air, Satellite Characteristics: orbits, swaths, Spatial Resolution, Pixel Size (IFOV, resolution cell), Spectral, Radiometric, Temporal Resolution, Cameras and Aerial Photography, Multispectral and Hyperspectral Scanning, Thermal Imaging, Geometric Distortion, Different Satellites:	08
	All Weather Satellites, Land Observation, Marine Observation, LIDAR, FLIR, RADAR, Side looking Radar.	
3	**Microwave Remote Sensing** • Introduction, RADAR Basics, Viewing Geometry, RADAR Image Distortions, Target Interaction and Image Appearance, RADAR Image Properties, RADAR Polarimetry (Polarization, Signatures, Backscatter, Parameters Affecting Backscatter, Applications), Synthetic Aperture RADAR (SAR), Airborne and Spaceborne Radars.	7
4	**Image Transforms** • Visual Image Analysis (tone, shape, size, pattern, texture, shadow, and Association), Digital Image Processing steps (Pre-processing, Enhancement, Transformation and Classification), Contrast Enhancement: Global, Local Techniques, Filtering, Image Transformations: Arithmetic Operations (Subtraction, Spectral Ratio, NDVI, PCT, FT,)	07
5	**Image Classification and Analysis** • Visual Interpretation, Image Classification: Optimum band selection, Supervised (Minimum Distance, Parallelopiped and Maximum Likelihood), Assessment of Classification Accuracy (Confusion or Error Matrix, Omission and Commission Error, Kappa Coefficient), Unsupervised Classification techniques: K-means,	7
6	**Applications of Remote Sensing** • Agriculture, Forestry, Land Cover/ Land Use Mapping, Water Resources, Snow and Glacier, Wetland Management, Oceans and Coastal, Soil Moisture	04

		Total	39

Textbooks and References:

Textbooks:

1. *Fundamentals of Remote Sensing***,** George Joseph, Universities Press; Second Edition, ISBN-10: 817371535, ISBN-13: 978-8173715358
2. *Remote Sensing: Models and Methods for Image Processing***,** Robert A. Schowengerdt, Academic Press, Third Edition, ISBN-10: 8131203182, ISBN-13: 978-8131203187
3. *Remote Sensing and Image Interpretation***,** Lillesand, Kiefer, Chipman, Wiley, Sixth Edition, ISBN-10: 8126532238, ISBN-13: 978-8126532230

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2021	**Error Control Coding**	**03**

Course Pre-requisite:

- Digital Communication
- Applied Maths

Course Objectives:

The aim of this course is

- To provide students a sound knowledge of traditional and modern coding theory, the motivation behind synthesis of channel coding techniques.

Course Outcome:

Learners will be able to:

- Design channel codes for the physical layer and storage applications
- Design new channel codes for wired/wireless communication systems

Module	Detailed Content	Hours
1	**Introduction to Algebra** • Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.	06

2	**Linear Codes** • Block codes: Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes, Golay code, Product codes and Interleaved codes. • Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, Golay code, Shortened cyclic codes.	08
3	**BCH Codes** • Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm.	06
4	**Convolutional Codes** • Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.	07
5	**Concatenated Codes and Turbo Codes** • Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes.	06
6	**Burst Error Correcting Codes** • Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.	06
	Total	39

Textbooks and References:

1. Shu Lin & Daniel J. Costello, Jr. *“Error Control Coding”* Prentice Hall, Second Edition, 2004.
2. S. B Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice

Hall International, 1995.
3. Blahut R. E, *Theory and Practise of Error Control Codes*, Addisson Wesley, 1983
4. Blahut R.E., *Algebraic codes for Data transmission*, Cambridge University Press, 2003.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2022	**Wireless Adhoc and Sensor Networks**	**03**

Course Pre-requisite:

- Computer Networks
- Wireless Networks

Course Objectives:

The aim of this course is to let the students

- To understand the Wireless adhoc and sensor Network.
- To understand the major challenges and designing issues in designing wireless sensor and adhoc networks.
- To understand various MAC and routing protocols in wireless sensor and adhoc networks.
- To Understand Heterogeneous network architecture including MANET, WLAN, Cellular Networks.

Course Outcome:

Learners will be able to:

- Understand and explain the concept of adhoc and sensor networks and their applications.

- Set up and evaluate performance of various protocols in wireless sensor and adhoc networks.
- Understand TCP performance over adhoc network.
- Understand integration of MANET, cellular Network and WLAN.

Module	Detailed Content	Hours
1	**Introduction to MANET and Wireless Sensor Network** • Challenges and Applications of MANET, Design issues and application of sensor Network, Sensing and Communication Range, Energy and Clustering of sensors, Wireless mesh Network, Architecture and Challenging technologies.	06
2	**Routing in Adhoc Networks** • Introduction, Topology-Based versus Position-Based Approaches, Topologies-Based Routing Protocols, Position-Based Routing, Other Routing Protocols, Wireless LAN, Wireless PAN, Wireless BAN .	06
3	**Broadcasting, Multicasting, Geocasting and QoS in MANET** • Introduction, The Broadcast Storm, Multicasting, Geocasting, QOS requirements, objectives and Architecture	06
4	**TCP over Adhoc Networks** • Introduction, TCP Protocol Overview, TCP and MANETs,	06
	Solutions for TCP over Adhoc.	
5	**Design Consideration in Sensor Network** • Introduction, Classifications of WSNs, MAC Layer, Routing Layer, High Level Application Layer Support, Adapting to the Inherent Dynamic Nature of WSNs, Cognitive Radio based sensor Networks. Nano Sensor Networks.	09
6	**Integrating MANETs, WLANs and Cellular Networks** • Introduction, Ingredients of a Heterogeneous Architecture, Protocol Stack, Comparison of the Integrated Architectures.	06
	Total	39

Textbooks and References:

1. *Adhoc & Sensor Networks Theory and Applications* by Cordeiro, Agrawal, Cambridge University Press India Pvt. Ltd, Edition 2010.
2. *Adhoc Wireless Networks Architecture and Protocols* by C.Siva Ram Murthy and B.S.Manoj, Pearson.
3. *Adhoc & Sensor Networks* by Houda Labiod, Wiley.
4. *Wireless Communication and Networking*-Vijay Garg, Elsevier Inc.

5. *Wireless and Mobile Networks, Concepts and Protocols* by Manvi, Kakkasageri, second edition, Wiley.

Assessment Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETPE2023	**Cognitive Radio**	**03**

Course Pre-requisite:

- Digital communication

Course Objectives:

The aim of this course is to let the students

- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.
- To understand the working of cognitive radio.
- To understand the major challenges and designing issues in using the bandwidth

Course Outcome:

Learners will be able to:

- Gain knowledge on multirate systems.
- develop the ability to analyze, design, and implement any application using
- Be aware of how signal processing concepts can be used for efficient FPGA based system design.
- understand the rapid advances in Cognitive radio technologies

- explore DDFS, CORDIC and its application

Text Books

1. J. H. Reed, –Software Radio‖, Pearson, 2002.
2. U. Meyer – Baese , –Digital Signal Processing with FPGAs‖, Springer, 2004.
3. H. Arslan –Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems‖, University of South Florida, USA, Springer, 2007.

Reference Books

1. S. K. Mitra, –Digital Signal processing‖, McGrawHill, 1998
2. K.C.Chen, R.Prasad , –Cognitive Radio Networks‖ , Wiley, 2009-06-15.
3. T. W. Rondeau, C.W.Bostian, ―Artificial Intelligence in Wireless Communications‖ ,2009.
4. Tusi, –Digital Techniques for Wideband receivers‖, Artech House, 2001.
5. T. DarcChiueh, P. Yun Tsai,‖ OFDM baseband receiver design for wireless communications‖,

   Wiley, 2007

Module	Detailed Content	Hours
1	Filter banks-uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem. Discrete multitone modulation and its realization using DFT. QMF.STFT.Computation of DWT using filter banks.	08
2	DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC.CORDIC architectures.	06
3	Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes	09
4	Concept of Cognitive Radio, Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks,Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,	04

5	A Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation.	06
6	Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.	06
	Total	39

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Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by student.

Subject Code	Subject Name	Credits
ETIE2011	**Project Management**	**03**

Course Objectives:

The aim of this course is

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcome:

Learners will be able to:

- Apply selection criteria and select an appropriate project from different options.

- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Content	Hours
1	**Project Management Foundation:** • Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	05
2	**Initiating Projects:** • How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	06
3	**Project Planning and Scheduling** • Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
4	**Planning Projects** • Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. • Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	06

5	**Executing Projects:** • Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. • Team management, communication and project meetings. **Monitoring and Controlling Projects:** • Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** • Project procurement management, contracting and outsourcing	08
6	**Project Leadership and Ethics:** • Introduction to project leadership, ethics in projects. • Multicultural and virtual projects. **Closing the Project:** • Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	06

Textbooks and References:

1. Jack Meredith & Samuel Mantel, *Project Management: A managerial approach*, Wiley India, 7th Ed.
2. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 5th Ed, Project Management Institute PA, USA
3. Gido Clements, *Project Management*, Cengage Learning.

4. Gopalan, *Project Management*, , Wiley India
5. Dennis Lock, *Project Management*, Gower Publishing England, 9th Ed.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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Subject Code	Subject Name	Credits
ETIE2012	**Finance Management**	**03**

Course Objectives:
The aim of this course is

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course Outcome:
Learners will be able to:

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Content	Hours
1	**Overview of Indian Financial System** • Characteristics, Components and Functions of Financial System. **Financial Instruments** • Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets** • Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions** • Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
2	**Concepts of Returns and Risks** • Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous • Discounting	06

3	**Overview of Corporate Finance** • Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis** • Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
4	**Capital Budgeting** • Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management** • Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity‘s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance** • Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure** • Factors Affecting an Entity‘s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
6	**Dividend Policy** • Meaning and Importance of Dividend Policy; Factors Affecting an Entity‘s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon‘s Approach, Walter‘s Approach, and Modigliani-Miller Approach	03

Textbooks and References:

1. *Fundamentals of Financial Management*, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. *Analysis for Financial Management*, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. *Indian Financial System*, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. *Financial Management*, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment

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End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2013	**Entrepreneurship Development and Management**	**03**

Course Objectives:

The aim of this course is

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME.

Course Outcome:

Learners will be able to:

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India Understand government policies for entrepreneurs

Module	Detailed Content	Hours
1	**Overview Of Entrepreneurship** • Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership • Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
2	**Business Plans And Importance Of Capital To Entrepreneurship** • Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur • **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
3	• Women‘s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05

4	**Indian Environment for Entrepreneurship** - Key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
5	**Effective Management of Business** - Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
6	**Achieving Success In The Small Business** - Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Textbooks and References:

1. Poornima Charantimath, *Entrepreneurship development- Small Business Enterprise*, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, *Entrepreneurship*, latest edition, The McGrawHill Company
3. Dr TN Chhabra, *Entrepreneurship Development*, Sun India Publications, New Delhi
4. Dr CN Prasad, *Small and Medium Enterprises in Global Perspective*, New century Publications, New Delhi
5. Vasant Desai, *Entrepreneurial development and management*, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, *Entrepreneurship*, Excel Books
7. Rashmi Bansal, *STAY hungry STAY foolish*, CIIE, IIM Ahmedabad
8. *Law and Practice relating to Micro, Small and Medium enterprises,* Taxmann Publication Ltd.
9. Kurakto, *Entrepreneurship- Principles and Practices,* Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment

Internal:	Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2014	**Human Resource Management**	**03**

Course Objectives:

The aim of this course is

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today‘s organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Course Outcome:

Learners will be able to:

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today‘s emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Content	Hours
1	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	05
2	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	07

	• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor) • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
3	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	06
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	05
5	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	06

6	**HR & MIS** - Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** - Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations**	05
	- Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Textbooks and References:

1. Stephen Robbins, *Organizational Behavior*, 16th Ed, 2013
2. V S P Rao, *Human Resource Management*, 3rd Ed, 2010, Excel publishing
3. Aswathapa, *Human resource management: Text & cases*, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, *Dynamics of Industrial Relations in India*, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, *Essentials of Human Resource management and Industrial relations*, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, *Management & Organizational Behavior*, Latest Ed, 2016, Pearson Publications

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2015	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Course Objectives:
The aim of this course is

- To understand professional ethics in business
- To recognized corporate social responsibility

Course Outcome:
Learners will be able to:

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Content	Hours
1	**Professional Ethics and Business:** • The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
2	**Professional Ethics in the Marketplace** • Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment** • Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
3	**Professional Ethics of Consumer Protection** • Markets and Consumer Protection; Contract View of Business Firm‘s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination** • Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
4	**Introduction to Corporate Social Responsibility** • Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. • Trajectory of Corporate Social Responsibility in India	05

5	**Corporate Social Responsibility** • Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
6	**Corporate Social Responsibility in Globalizing India** • Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Textbooks and References:

1. *Business Ethics: Texts and Cases from the Indian Perspective (2013)* by Ananda Das Gupta; Publisher: Springer.
2. *Corporate Social Responsibility: Readings and Cases in a Global Context (2007)* by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. *Business Ethics: Concepts and Cases*, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. *Corporate Social Responsibility in India (2015)* by Bidyut Chakrabarty, Routledge, New Delhi.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2016	**Research Methodology**	**03**

Course Objectives:
The aim of this course is

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcome:
Learners will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
Review and analyze research findings

Module	Detailed Content	Hours
1	**Introduction and Basic Research Concepts** • Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology • Need of Research in Business and Social Sciences • Objectives of Research • Issues and Problems in Research • Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
2	**Types of Research** • Basic Research • Applied Research • Descriptive Research • Analytical Research • Empirical Research • Qualitative and Quantitative Approaches	07
3	**Research Design and Sample Design** • Research Design – Meaning, Types and Significance • Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07

4	**Research Methodology**
	• Meaning of Research Methodology
	• Stages in Scientific Research Process:
	    • Identification and Selection of Research Problem
	    • Formulation of Research Problem
	    • Review of Literature
	    • Formulation of Hypothesis
	    • Formulation of research Design
	    • Sample Design
	    • Data Collection
	    • Data Analysis
	    • Hypothesis testing and Interpretation of Data
	    • Preparation of Research Report
		08

5	**Formulating Research Problem** • Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
6	**Outcome of Research** • Preparation of the report on conclusion reached • Validity Testing & Ethical Issues • Suggestions and Recommendation	04

Textbooks and References:

1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques*, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nded), Singapore, Pearson Education

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2017	**IPR and Patenting**	**03**

Course Objectives:

The aim of this course is

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course Outcome:

Learners will be able to:

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Content	Hours
1	**Introduction to Intellectual Property Rights (IPR)** • Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment** • Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
2	**Enforcement of Intellectual Property Rights** • Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR** • Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
3	**Emerging Issues in IPR** • Challenges for IP in digital economy, e-commerce, human	05

	genome, biodiversity and traditional knowledge etc.	
4	**Basics of Patents** • Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
5	**Patent Rules** • Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
6	**Procedure for Filing a Patent (National and International)** • Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases** • Important websites, Searching international databases	07

Textbooks and References:

1. Rajkumar S. Adukia, 2007, *A Handbook on Laws Relating to Intellectual Property Rights in India*, The Institute of Chartered Accountants of India
2. Keayla B K, *Patent system and related issues at a glance*, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, *Intellectual Property Law in India*, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, *Intellectual Property and Human Development: Current Trends and Future Scenario*, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right*, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, *The enforcement of Intellactual Property Rights: A Case Book*, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, *Intellectual Property Rights*, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, *Intellectual Property Rights*, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, *Intellectual Property Rights*, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, *Fundamentals of IPR for Engineers*, 1st Edition, BS Publications

11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, *A Manual on Intellectual Property Rights*.
12. Mathew Y Maa, 2009, *Fundamentals of Patenting and Licensing for Scientists and Engineers,* World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** *IPR: Drafting, Interpretation of Patent Specifications and Claims***,** New India Publishing Agency
14. Vivien Irish, 2005, *Intellectual Property Rights for Engineers,* IET
15. Howard B Rockman, 2004, *Intellectual Property Law for Engineers and scientists,* Wiley-IEEE Press

Assessment

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Subject Code	Subject Name	Credits
ETIE2018	**Digital Business Management**	**03**

Course Objectives:
The aim of this course is

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course Outcome:
Learners will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed Content	Hours
1	**Introduction to Digital Business** • Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts • Difference between physical economy and digital economy, **Drivers of digital business** • Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) • Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** • **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement • B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals • Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing • EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**	06

	• ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development** • Building Digital business Applications and Infrastructure	
4	**Managing E-Business** • Managing Knowledge, Management skills for e-business, Managing Risks in e –business • Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy** • E-business Strategic formulation- Analysis of Company‘s Internal and external environment, Selection of strategy, • E-business strategy into Action, challenges and E-Transition • (Process of Digital Transformation)	04
6	**Materializing e-business** • From Idea to Realization-Business plan preparation • Case Studies and presentations	08

Textbooks and References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. *E-commerce from vision to fulfilment*, Elias M. Awad, PHI-Restricted, 2002
3. *Digital Business and E-Commerce Management*, 6th Ed, Dave Chaffey, Pearson, August 2014
4. *Introduction to E-business-Management and Strategy*, Colin Combe, ELSVIER, 2006
5. *Digital Business Concepts and Strategy*, Eloise Coupey, 2nd Edition, Pearson
6. *Trend and Challenges in Digital Business Innovation*, Vinocenzo Morabito, Springer
7. *Digital Business Discourse* Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. *Perspectives the Digital Enterprise –A framework for Transformation*, TCS consulting journal Vol.5
10. *Measuring Digital Economy-A new perspective* -DOI:10.1787/9789264221796-en OECD Publishing

Assessment

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End Semester Examination:	Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Credits
ETIE2019	**Environmental Management**	**03**

Course Objectives:
The aim of this course is

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course Outcome:
Learners will be able to:

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Content	Hours
1	**Introduction and Definition of Environment** • Significance of Environment Management for contemporary managers, Career opportunities. • Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
2	**Global Environmental concerns** • Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
3	**Concepts of Ecology** • Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
4	• Scope of Environment Management, Role & functions of Government as a planning and regulating agency. • Environment Quality Management and Corporate Environmental Responsibility	10
5	• Total Quality Environmental Management, ISO-14000, EMS certification.	05
6	• General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Textbooks and References:

1. *Environmental Management: Principles and Practice*, C J Barrow, Routledge Publishers London, 1999
2. *A Handbook of Environmental Management* Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. *Environmental Management*, T V Ramachandra and Vijay Kulkarni, TERI Press
4. *Indian Standard Environmental Management Systems* — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. *Environmental Management: An Indian Perspective*, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. *Introduction to Environmental Management*, Mary K Theodore and Louise Theodore, CRC Press
7. *Environment and Ecology*, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment

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End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL201	**Program Lab-1**	**--**	**2 hrs**	**--**	**--**	**1**	**--**	**01**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ETL201	**Program Lab-1**	**--**	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Course Objectives:

3. To learn the concept of impedance matching and RF filters
4. To learn Microwave amplifiers, oscillators and mixer

Course Outcomes: Learners will be able to ...

3. Analyze impedance matching networks using simulation software.
4. Analyze RF filter, amplifiers, oscillators and mixer using simulation software.

Term Work:

At least 08 experiments covering the entire syllabus must be given –Batch Wise‖. Computation/simulation based experiments are also encouraged. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Suggested List of experiments:

1. To Study the non-ideal characteristics of Lumped elements using spectrum/network analyzer.
2. Analysis of the Low-Pass and High pass composite filter design using simulation software.
3. Analysis of the filter design by Insertion Loss method using simulation software.
4. Study the impedance matching in case of real and imaginary loads using simulation software.
5. Analysis of a Low Noise Amplifier (LNA)using simulation software.
6. Analysis of Microwave Oscillator using simulation software and its demonstration using spectrum analyzer.
7. Measurement of gain factor & tunable bandwidth of voltage control oscillator (VCO) using spectrum analyzer.
8. Analysis of simple mixer using time domain and frequency domain response using simulation software.
9. Demonstrate the different stages of microwave amplifier using spectrum analyzer.
   Common-Mode Currents and Radiated Emissions of Cables

R19- SE

University of Mumbai

No. UG/ 48 of 2021

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus directly uploaded by the Academic Authority Unit which was accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No.4.177 relating to the revised syllabus as per the (CBCGS) for Bachelor of Engineering (Civil Engineering) Second Year (Sem.III & IV), (Rev – 2016) from Academic Year 2017-18.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 29th May, 2020 and subsequently made by the Board of Deans at its meeting held on 26th June, 2020 vide item No. 14(9) have been accepted by the Academic Council at its meeting held on 23rd July, 2020 **vide** item No. 4.125 and that in accordance therewith, the Scheme (Sem. III to VIII) and revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Civil Engineering (Sem.III & IV) has been brought into force with effect from the academic year 2020-21. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
21st January, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.125/23/07/2020

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No. UG/ 48 -A of 2021 MUMBAI-400 032 21st January, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

Item No: 125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester - III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics-III	3	-	1	3	-	1	4
CEC302	Mechanics of Solids	4			4			4
CEC303	Engineering Geology	3			3			3
CEC304	Architectural Planning & Design of Buildings	2	-	-	2	-	-	2
CEC305	Fluid Mechanics- I	3	-	-	3	-	-	3
CEL301	Mechanics of Solids	-	2	-	-	1	-	1
CEL302	Engineering Geology	-	2	-	-	1	-	1
CEL303	Architectural Planning & Design of Buildings	-	2	-	-	1	-	1
CEL304	Fluid Mechanics- I	-	2	-	-	1	-	1
CEL305	Skill Based Lab Course-I		3		-	1.5		1.5
CEM301	Mini Project – 1 A	-	$3^{\$}$	-	-	1.5	-	1.5
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Prac. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		Test I	Test II	Avg.					
CEC301	Engineering Mathematics-III	20	20	20	80	3	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	3	-	-	100
CEC303	Engineering Geology	20	20	20	80	3	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	3	-	-	100
CEC305	Fluid Mechanics- I	20	20	20	80	3	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics- I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course-I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1 A	-	-	-	-	-	25	25	50
Total				**100**	**400**	-	**200**	**125**	**825**

Semester - IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC 401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC 402	Structural Analysis	4	--	-	4	-	-	4
CEC 403	Surveying	3	--	-	3	-	-	3
CEC 404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC 405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course - II	--	2	-	-	1	-	1.5
CEM401	Mini Project – 1 B	--	$3^{\$}$	-	-	1.5	-	1
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Prac./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (hrs.)			
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials &Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course - II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
Total				100	400	-	225	125	850

Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC 501	Theory of Reinforced Concrete structures	3	-	-	3	-	-	3
CEC 502	Applied Hydraulics	3	-	-	3	-	-	3
CEC 503	Geotechnical Engineering-I	3	-	-	3	-	-	3
CEC 504	Transportation Engineering	4	-	-	4	-	-	4
CEDO 501	**Department Optional Course - 1**	3	-	-	3	-	-	3
CEL 501	Theory of Reinforced Concrete structures	-	2	-	-	1	-	1
CEL 502	Applied Hydraulics	-	2	-	-	1	-	1
CEL 503	Geotechnical Engineering-I		2			1		1
CEL 504	Transportation Engineering	-	2	-	-	1	-	1
CEL 505	Business Communication and Ethics	-	$2^{*}+2$			2		2
CEM 501	Mini Project – 2A	-	$4^{\$}$	-	-	2	-	2
	Total	**16**	**16**		**16**	**8**		**24**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Prac./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Dura-tion (Hrs.)			
		Test 1	Test 2	Avg.					
CEC 501	Theory of Reinforced Concrete structures	20	20	20	80	3	-	-	100
CEC 502	Applied Hydraulics	20	20	20	80	3	-	-	100
CEC 503	Geotechnical Engineering-I	20	20	20	80	3	-	-	100
CEC 504	Transportation Engineering	20	20	20	80	3	-	-	100
CEDO 501	**Department optional course-1**	20	20	20	80	3	-	-	100
CEL501	Theory of Reinforced Concrete structures						25	25	50
CEL502	Applied Hydraulics						25	25	50
CEL 503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Business Communication and Ethics	-	-	-	-	-	50	-	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
	Total			**100**	**400**	-	**175**	**125**	**800**

Semester - VI

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC 601	Design and Drawing of Steel Structure	3	-		3	-	-	3
CEC 602	Water Resources Engineering	3	-	-	3	-	-	3
CEC 603	Geotechnical Engineering-II	3	-	-	3	-	-	3
CEC 604	Environmental Engineering	4	-	-	4	-	-	4
CEDO 601	**Department Optional Course-2**	3	-	-	3	-	-	3
CEL 601	Design and Drawing of Steel Structure	-	2	-	-	1	-	1
CEL 602	Water Resources Engineering	-	2	-	-	1	-	1
CEL 603	Geotechnical Engineering-II	-	2	-	-	1	-	1
CEL 604	Environmental Engineering		2			1		1
CEL 605	Skill based lab Course-III	-	3	-	-	1.5	-	1.5
CEM 601	Mini Project – 2B	-	$3^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**		**16**	**7**		**23**

Examination Scheme

Course Code	**Course Name**	**Theory**					**Term Work**	**Pract /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (Hrs.)**			
		Test 1	Test 2	Avg.					
CEC 601	Design and Drawing of Steel Structure	20	20	20	80	3	-	-	100
CEC 602	Water Resources Engineering	20	20	20	80	3	-	-	100
CEC 603	Geotechnical Engineering-II	20	20	20	80	3	-	-	100
CEC 604	Environmental Engineering	20	20	20	80	3	-	-	100
CEDO 601	Department Optional Course-2	20	20	20	80	3	-	-	100
CEL 601	Design and Drawing of Steel Structure	--	--	-	-	-	25	25	50
CEL 602	Water Resources Engineering						25	25	50
CEL 603	Geotechnical Engineering-II	-	-	-	-	-	25	25	50
CEL 604	Environmental Engineering	-	-	-	-	-	25	25	50
CEL 605	Skill based lab Course-III	-	-	-	-	-	50	-	50
CEM 601	Mini Project – 2B	-	-	-	-	-	25	25	50
Total				**100**	**400**	-	**175**	**125**	**800**

Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract. Tut.	Total
CEC 701	Design and Drawing of Reinforced Concrete Structures	3	-	3	-	3
CEC 702	Quantity Survey, Estimation and valuation	3	-	3	-	3
CEDO 701	**Department Optional Course-3**	3	-	3	-	3
CEDO 702	**Department Optional Course-4**	3	-	3	-	3
CEIO 701	**Institute Optional course-1**	3	-	3	-	3
CEL 701	Design and Drawing of Reinforced Concrete Structures	-	2	-	1	1
CEL 702	Quantity Surveying, Estimation and valuation	-	2	-	1	1
CEP 701	Major Project - I	-	$6^{\$}$	-	3	3
	Total	**15**	**10**	**15**	**5**	**20**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		Test 1	Test 2	Avg.					
CEC 701	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	3		-	100
CEC 702	Quantity Survey Estimation and valuation	20	20	20	80	3	-	-	100
CEDO 701	**Department Optional Course-3**	20	20	20	80	3	-	-	100
CEDO 702	**Department Optional Course-4**	20	20	20	80	3			100
CEIO 701	**Institute Optional course-1**	20	20	20	80	3	-	-	100
CEL 701	Design and Drawing of Reinforced Concrete Structures	--	--	-	-	-	25	25	50
CEL 702	Quantity Survey Estimation and Evaluation	--	--	--	-	-	25	25	50
CEP 701	Major Project - I	--	--	-	-	-	50	-	50
	Total	--	--	**100**	**400**	-	**100**	**50**	**650**

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract. Tut.	Total
CEC 801	Construction Management	3	-	3		3
CEDO 801	**Department Optional Course -5**	**3**	**-**	**3**	-	**3**
CEDO 802	**Department Optional Course -6**	**3**	-	**3**	-	**3**
CEIO 801	**Institute Optional Course-2**	**3**	-	**3**	-	**3**
CEL 802	Construction Management	-	2	--	1	1
CEP 801	Major Project - II	-	$12^{\$}$-		6	6
Total		**12**	**14**	**12**	**7**	19

Examination Scheme

Course Code	Course Name	Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		Test 1	Test 2	Avg.					
CEC 801	Construction Management	20	20	20	80	3			100
CEDO 801	**Department Optional Course -5**	**20**	**20**	**20**	**80**	**3**			**100**
CEDO 802	**Department Optional Course -6**	**20**	**20**	**20**	**80**	**3**			**100**
CEIO 801	**Institute Optional Course-2**	**20**	**20**	**20**	**80**	**3**			**100**
CEL 802	Construction Management	-	-	-	-	-	25	25	50
CEP 801	Major Project - II	-	-	-	-	-	50	100	150
Total		-	-	80	320		75	125	600

Item No.4.125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Second Year B.E. Civil Engineering
2	Eligibility for Admission	After Passing First Year Engineering as per the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 semesters
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	With effect from Academic Year: 2020-2021

Date

Dr. S. K. Ukarande.
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Majumdar
Dr Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

Item No: 125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Item No: -125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Civil Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	**U.G.**
7	Pattern	**Semester**
8	Status	**New**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
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Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 "C" scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming sessions, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-gradute studies
4. To motivate learners for life-longing learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering, University of Mumbai

1. Dr. S. K. Ukarande: Chairman
2. Dr. K. K. Sangle: Member
3. Dr. S. B. Charhate: Member
4. Dr. A. R. Kambekar: Member
5. Dr. R. B. Magar: Member
6. Dr. Seema Jagtap: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester - III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics-III	3	-	1	3	-	1	4
CEC302	Mechanics of Solids	4			4			4
CEC303	Engineering Geology	3			3			3
CEC304	Architectural Planning & Design of Buildings	2	-	-	2	-	-	2
CEC305	Fluid Mechanics- I	3	-	-	3	-	-	3
CEL301	Mechanics of Solids	-	2	-	-	1	-	1
CEL302	Engineering Geology	-	2	-	-	1	-	1
CEL303	Architectural Planning & Design of Buildings	-	2	-	-	1	-	1
CEL304	Fluid Mechanics- I	-	2	-	-	1	-	1
CEL305	Skill Based Lab Course-I		3		-	1.5		1.5
CEM301	Mini Project – 1 A	-	3$	-	-	1.5	-	1.5
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg.					
CEC301	Engineering Mathematics-III	20	20	20	80	3	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	3	-	-	100
CEC303	Engineering Geology	20	20	20	80	3	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	3	-	-	100
CEC305	Fluid Mechanics- I	20	20	20	80	3	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics- I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course-I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1 A	-	-	-	-	-	25	25	50
	Total			**100**	**400**	**-**	**200**	**125**	**825**

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials &Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course-II	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	$3^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme										
Course Code	**Course Name**	**Internal Assessment**			**End Sem Exam**	**Exam Duration (Hrs.)-**	**Term Work**	**Prac. /Oral**	**Total**
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3			100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course-II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			**100**	**400**	-	**225**	**125**	**850**

Semester- III

Course Code	Course Name	Credits
CEC 301	Engineering Mathematics-III	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite: Engineering Mathematics-I,
Engineering Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at), cos(at), sinh(at), cosh(at)$ and t^n $, where\ n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	07 Hrs.
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	06 Hrs.
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	07Hrs.
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given.	07Hrs.

	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	
05	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. **(No theorems/ proof)** 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Functions of square matrix 5.4 Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	06 Hrs.
06	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method **Self-learning Topics:** Analytical methods of solving two and three dimensional problems.	06 Hrs.
	Total	39

Term Work:

General Instructions:

1 Batch wise tutorials are to be conducted. The number of student'sperbatch should be as per University pattern for practicals.

2 Students must be encouraged to write at least 6 class tutorials on entire syllabus.

3 A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks
2 Question 1 will be compulsory and should cover maximum contents of the curriculum
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4 Only Four questions need to be solved.

References:

1 Engineering Mathematics, Dr. B. S. Grewal, KhannaPublication
2 Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited,
3 Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosapublication
4 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5 Higher Engineering Mathematics B.V. Ramana, McGraw HillEducation
6 Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation,
7 Text book of Matrices, Shanti Narayan and P K Mittal, S. ChandPublication
8 Laplace transforms, Murray R. Spiegel, Schaum's OutlineSeries

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Semester- III		
Course Code	**Course Name**	**Credits**
CEC 302	**Mechanics of Solids**	**4**

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
4	-		4	-	--	4

Theory					Term Work/Practical/Oral			Total
Internal Assessment			**End Sem. Exam**	**Duration of End Sem Exam**	**TE**	**PR**	**OR**	
Test-I	**Test-II**	**Average**						
20	20	20	80	3 Hours	-	--	--	100

Rationale

Civil Engineering structures are made using various engineering materials such as steel, concrete, timber, other metals or their composites. They are subjected to force systems resulting into axial forces, bending moments, shear forces, torsion and their combinations. Different materials respond differently to these by getting deformed and having induced stresses. Determination of stress, strain, and deflection suffered by structural elements when subjected to diverse loads is prerequisite for an economical and safe design.

In this course, learners will understand the internal response behavior of material under different force systems. The knowledge of 'Mechanics of Solids' will be foundation of essential theoretical background for the subjects of Structural Analysis and Structural Design.

Objectives

1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members and thin cylinders subjected to internal pressure.
2) To learn to represent graphically the distribution of axial force, shear force and bending moment along the length of statically determinate beams and portal frames.
3) To compute area moment of inertia and to analyze the distribution of shear stress and the flexural (bending) stress across the cross section of structural members.
4) To study circular shafts under the action of twisting moment and to determine the direct and bending stresses in columns and study buckling behavior of centrally and eccentrically loaded columns.
5) To determine principal planes and stresses and strain energy computation in elastic members.
6) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Detailed Syllabus			
Module		**Course Modules / Contents**	**Periods**
1	**Module Name- Stresses and Strains in Elastic members, Spherical and Cylindrical shells**		**(9)**
	1.1	Types of Stresses and Strains, stress-strain curve, different types of Elastic moduli and relationships between them, Poisson's ratio, factor of safety. Bars of varying sections, composite sections, temperature stresses	**6**
	1.2	Thin cylindrical and spherical shells under Internal pressure: Determination of Hoop stress, Longitudinal stress, Shear stress and volumetric strain.	**3**
2	**Module Name- Axial force, shear force and bending moment diagrams for beams and portal frames**		**(9)**
	2.1	Concept of Axial Force, Shear Force and Bending Moment. a) A.F. S.F. and B M Diagrams for statically determinate S S and Cantilever **beams without internal hinges** and for single loading like point load, UDL, UVL or Couple moment. b) A.F. S.F. and B.M. Diagrams for statically determinate **beams with internal hinges** and combination of loading	**6**
	2.2	A.F. S.F. and B.M Diagrams for statically determinate **3-member Portal Frames with or without internal hinges .**	**3**
3	**Module Name- Area Moment of Inertia, Shear stresses and Bending stresses in beams**		**(9)**
	3.1	Area Moment of inertia, Parallel and Perpendicular axis theorem, polar moment of inertia. Radius of gyration. (Rectangular, Triangular, Circular, Semicircular section and their combination) Distribution of shear stress across plane sections Commonly used for structural purposes.	**5**
	3.2	Theory of pure bending, Flexure formula for straight beam, simple problems involving application of Flexure formula, section modulus, moment of resistance, flitch beams.	**4**
4	**Module Name- Torsion in Shafts, Columns**		**(10)**
	4.1	Torsion in solid and hollow circular shafts, shafts with varying cross sections, Shafts transmitting and receiving power at different points. Stresses in Shafts while transmitting power.	**4**
	4.2	Direct and bending stresses in Columns, Core of section.	**6**

		Buckling of Columns, Members subjected to axial loading, concept of buckling, effective length, different support conditions, Euler's and Rankine's formula. Concept of Eccentrically loaded columns.	
5	**Module Name- Principal planes and stresses, Strain Energy**		**(8)**
	5.1	General equation for transformation of stress, Principal planes and principal stresses, maximum Shear stress, stress determination by analytical and Graphical method (using Mohr's circle).	4
	5.2	Strain energy due to axial force and impact loads in columns, due to bending in beams, due to torsion of shaft.	4
6	**Module Name- Slope and Deflection in Beams , General Theorems**		**(7)**
	6.1	Concept of Slope and Deflection in Beams, Macaulay's Method for slope and deflection in S S and Cantilever beams subjected to point loads, UDL and couple moments.	4
	6.2	General Theorems: Betti and Maxwell's reciprocal Theorem,, Principle of Superposition, Principle of Virtual work, Castigliano's theorems.	3

Contribution to Outcome

On completion of this course, the students will be able to:

1) Evaluate stress - strain behavior of elastic members and thin cylinders subjected to internal pressure.
2) Draw variation of axial force, shear force and bending moment diagram for statically determinate beams and frames.
3) Calculate Moment of Inertia for cross sections and analyse the material response under the action of shear and the effect of flexure (bending).
4) Predict the angle of twist and shear stress developed in torsion and compute direct and bending stresses developed in the cross section of centrally and eccentrically loaded columns.
5) Locate principal planes in members and calculate principal stresses using analytical and graphical method and to calculate strain energy stored in members due to elastic deformation.
6) Evaluate slope and deflection of beams supported and loaded in different ways.

Internal Assessment (20 Marks):

One **Compulsory Class Test,** based on approximately 40% of contents and another on 40% from the remaining content be taken. Average of the two will be considered as IA Marks.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture

Hours mentioned in the curriculum.

1) Question paper will comprise of total **six questions, each carrying 20 marks.**
2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4) Only **Four questions need to be solved.**

Recommended Books:

1. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and Jaan Kiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and Nillanjan Mallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

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Semester-III

Course Code	Course Name	Credits
CEC 303	Engineering Geology	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3		-	3		-	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	3 hrs		-		100

Rationale

Engineering geology is an applied geology discipline that involves the collection, analysis, and Interpretation of geological data and information required for the safe development of civil works. The objective of this course is to focus on the core activities of engineering geologists – site characterization, geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock in the characterization of geologic sites for civil work projects.

Understanding of the foundation rocks and structures present in them is of utmost importance for the safety and stability of Civil engineering structures. The study also helps in the assessment of groundwater, oil and gas and mineral resource evaluation.

Objectives

1. To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
2. To study minerals and rocks in order to understand their fundamental characteristics and engineering properties.
3. To study structural geology for characterization of site, analysis and report geologic data using standards in engineering practice.
4. To study methods of subsurface investigation, advantages and disadvantages caused due to geological conditions and assessment of site for the construction of civil structures.
5. To study rock mass characterization for the construction of tunnels and assessment of rock as source of ground water.
6. To study the control of geology over the natural hazards and their preventive measures.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Introduction & Physical Geology**	5
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects. Departments dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth. Theory of Plate Tectonics.	
	1.3	Weathering types, Erosion and Denudation. Factors affecting weathering and product of weathering (engineering consideration) Superficial deposits and its geological Importance.	
	1.4	Brief study of geological action of wind, glacier and river.	
2		**Mineralogy and Petrology**	7
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, form of Igneous rocks, Classification of Igneous rocks, study of commonly occurring igneous rocks, Engineering aspect of Granite and Basalt.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	
3		**Structural Geology and Stratigraphy**	12
	3.1	Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Type of discontinuities in the rocks. **Fold:** Terminology, Classification on the basis of position of axial plane, Criteria for their recognition in field and engineering consideration. **Fault:** Terminology, Classification on the basis of movement of faulted block, Criteria for recognition in field, effects on outcrops and Engineering consideration.	

		Joints & Unconformity: Types and geological importance. Three point problems to determine attitude of the strata	
	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	Geological Maps and their application for civil engineering works, Identification of symbols in maps.	
	3:4	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province.	
4	**Geological Investigation, study of dam and reservoir site:**		7
	4.1	Required geological consideration for selecting dam and reservoir site. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions.	
	4.2	Electrical resistivity and Seismic method of geological investigation. Rock Quality Designation and its importance to achieve safety and economy of the projects like dams and tunnels.	
	4.3	Borehole problems and their significance in determining subsurface geology of the area.	
5	**Tunnel Investigation and Ground Water Control**		5
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions.	
	5.2	Geo-mechanics classification (RMR) and its application.	
	5.3	Sources, zones, water table, unconfined, confined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Different types of rocks as source of ground water. Artesian well (flowing and non-flowing). Cone of Depression and its use in Civil engineering.	
6	**Geological Disasters and Control Measures**		3
	6.1	Landslides-Types, causes and preventive measures for landslides, Landslides in Deccan region.	
	6.2	Volcano- Central type and fissure type, products of volcano.	
	6.3	Earthquake- Terminology, Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory, Preventive measures for structures constructed in Earthquake prone area.	

Contribution to Outcome

On completion of this course, the students will be able to:

1) Explain the concepts of Geology and its application for safe, stable and economic design of any civil engineering structure.
2) Interpret the lithological characters of the rock specimen and distinguish them on the basis of studied parameters.
3) Describe the structural elements of the rocks and implement the knowledge for collection and analysis of the geological data.
4) Interpret the geological conditions for the dam site and calculate RQD for the assessment of rock masses.
5) Analyze the given data and suggest rock mass rating for assessment of tunnelling conditions.
6) Interpret the causes of geological hazards and implement the knowledge for their prevention.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests** - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecturehours mentioned in the curriculum.

1) Question paper will comprise of total **six questions, each carrying 20 marks.**
2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4) Only **Four questions need to be solved.**

Recommended Books:

1) Text book of Engineering Geology: N. Chenna, Kesavulu, Mc-Millan.
2) Text book of Engineering and General Geology, 8th edition (2010): Parbin Singh, S K Kataria& Sons.
3) Text book of Engineering Geology: P. K. Mukerjee, Asia.
4) Text book of Engineering Geology: Dr. R. B. Gupte, Pune VidyarthiGriha
5) Prakashan, Pune.
6) Principles of Engineering Geology: K. M. Banger.

Reference Books:

7) A Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
8) Structural Geology, 3rd edition (2010): Marland P. Billings, PHI Learning Pvt. Ltd. New Delhi
9) Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
10) Principles of Geomorphology: William D. Thornbury, John Wiley Publications, New York.
11) Geology for Civil Engineering: A. C. McLean, C.D. Gribble, George Allen &UnwinLondon.
12) Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

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Semester - III

Course Code	Course Name	Credits
CEC304	Architectural Planning & Design of Buildings	02

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
02	-	-	02	-	-	02

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	---	-		100

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

1) To remember and recall the intricate details of building design and drawing.
2) To gain an understanding of the basic concepts of building design and drawing.
3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices, rules, regulation and byelaws, Building codes
4) To identify, analyze, research literate and solve complex building design and drawing problems.
5) To have new solutions for complex building design and drawing problems.
6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes

At the end of the course learners will be able to:

1) Remember and recall the intricate details of building design and drawing.
2) Understand the basic concepts of building design and drawing.
3) Learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4) Identify, analyze, research literate and solve complex building design and drawing problems.
5) Have new solutions for complex building design and drawing problems.
6) Effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus

Module	Sub- Modules/ Contents	Periods
1	**Principles and Codes of Practices for Planning and Designing of Buildings(Residential and Public buildings)**	8
1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings; How to develop Line plan into actual PLAN, ELEVATION, Section etc. including all the constructional details of various components in a BUILDING	
1.2	Principles of planning for Residential buildings	
1.3	Classification of buildings: Residential –Individual Bungalows & Apartments/Flats. Public – Education (Schools, Colleges etc.) &Health (Primary Health Center, Hospital) related buildings	
1.4	Study & drawing of SITE PLAN,FOUNDATION PLAN,ROOF PLAN of building; Study of building Bye – laws, Zoning Regulations and permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
1.6	Calculation of setback distances, carpet area, built-up area and floor spaceindex (FSI)	
1.7	Study of Principles of planning for public buildings: i) Building for education: schools, colleges, institutions etc. ii) Buildings for health: hospitals, primary health centers etc.	
2.	**Components and Services of a Building**	3
2.1	Staircase (dog -legged) planning, designing & drawing in details	
2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
2.3	Openings: doors and windows	
2.4	Types of pitched roof and their suitability (plan and section)	
2.5	Building services: Water supply, sanitary and electrical layouts	
3.	**Perspective Drawings**	4
3.1	One-point perspective drawing	
3.2	Two-point perspective drawing	
4	**Town Planning, Architectural Planning & Built Environment**	3
4.1	Objectives and planning of TOWN PLANNING	
4.2	Master plan, Re-Development of buildings, Slum rehabilitation.	
4.3	Architectural Planning: introduction and principles	
4.4	Built Environment: introduction and principles	
5	**Green Buildings**	2
5.1	Introduction, uses ,objectives of Green Buildings and overview	
5.2	Study of Certification methods such as LEED, TERI, GRIHA, IGBC.	
6.	**Computer Aided Drawing (CAD)**	6
6.1	Details and learning methods of CAD in Civil Engineering structures	
6.2	Study and demonstration of any one of the professional CAD software's	
	Total	**26**

Theory Examination:

1) Only 4 questions (out of 6) need to be attempted.
2) Question no. 1 will be compulsory and based on the drawing work of any one building, may be residential or public building.. Some questions from the remaining may be on Theory portion.
3) 4. Any 3 out of the remaining 5 questions need to be attempted.
4) In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Internal Assessment:

There will be **Two** class tests (to be referred to as an '**Internal Assessment'**) to be conducted in the semester. The first internal assessment (IA-I) will be conducted in the mid of the semester based on the 50% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA-II) will be conducted at the end of the semester and it will be based on next 50% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)

Recommended Books

1) Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)
2) Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)
3) Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi)

References:

1) IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2) National Building Code of India – 2005 (NBC 2005)
3) Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)
4) Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5) Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

1) National Building Code of India, 2005
2) IS 779-1978 Specification for Water Meter
3) IS 909-1975 Specification for Fire Hydrant
4) IS 1172-1983 Code of Basic Requirement for Water Supply, Drainage & Sanitation
5) IS 1742-1983 Code of Practice for Building Drainage

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Semester- III

Course Code	Course Name	Credits
CEC305	Fluid Mechanics - I	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	100

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science offluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics andhydrodynamics with their applications in fluid flow problems.

Objectives

The students will be able to learn:

1. The properties of fluids, units and dimensions
2. Pressure measurement, manometry, Hydrostatic forces acting on different surfaces, Principle of buoyancy and stability of floating body
3. Kinematic and Dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
4. Importance of fluid flow and various velocity measuring and discharge measuring devices used in pipes and channels.
5. The basic difference between incompressible and compressible flow, Propagation of pressure waves and stagnation points.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1	**Properties of Fluids**		05
	Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, and introduction to real life applications.		
2	**Fluid Statics**		11
	2.1	**Pressure Measurement:** Pascal's law, hydrostatic law, pressure variation in fluids at rest. Pressure scale, Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	**Hydrostatic force on surfaces:**	

		Total pressure and centre of pressure, total pressure on horizontal planesurface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	**Buoyancy and floatation:** Archimedes principle, Meta-Centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, Experimental and analytical methods, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
3		**Fluid Kinematics**	05
		Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, streamline, streak line, path line,velocity potential and stream function, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity	
4		**Fluid Dynamics**	06
		Control volume and control surface, Forces acting on fluid in motion, Navier Stokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, Rota meter.	
5		**Flow measurement**	08
	5.1	**Orifices and mouthpieces** Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	5.2	**Notches and weirs** Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolleti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
6	6.1	**Compressible flow**	04
		Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties.	
Total			39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

1) Describe various properties of fluids and types of flow
2) Determine the pressure difference in pipe flows, application of Continuity equation and Bernoulli's theorem to determine velocity and discharge
3) Apply hydrostatic and dynamic solutions for fluid flow applications
4) Analyse the stability of floating bodies
5) Apply the working concepts of various devices to measure the flow through pipes and channels
6) Explain the compressible flow, propagation of pressure waves and stagnation properties

Internal Assessment (20 Marks):

Consisting Two Compulsory Class Tests:

First test based on approximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1) Question paper will comprise of total **six questions, each carrying 20 marks.**
2) **Question 1**will be compulsory and should **cover maximum contents of the curriculum**
3) **Remaining questions will be mixed in nature**(for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4) Only **Four questions need to be solved.**

Recommended Books:

1) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
2) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
3) Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt.Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
5) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
6) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Reference Books:

1) Fluid Mechanics: Frank M. White, Tata McGraw Hill International Edition.
2) Fluid Mechanics: Streeter White Bedford, Tata McGraw International Edition.
3) Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Fennimore, Tata McGraw Hill, New Delhi.
4) Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
5) Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.

Semester- III

Course Code	Course Name	Credits
CEL301	Mechanics of Solids- LAB	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members.
2) To compute the distribution of shear stress and the flexural (bending) stress across the cross section of structural members
3) To study circular shafts under the action of twisting moment.
4) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Outcomes

Learner will be able to…

1) Evaluate stress - strain behavior of materials and assess the structural behavior by the virtue of stresses developed and deformation of elastic members.
2) Analyze the material response under the action of shear and the effect of flexure (bending).
3) Predict the angle of twist and shear stress developed in torsion.
4) Evaluate slope and deflection of beams supported and loaded in different ways.

Term Work : Term work comprises of Laboratory work and assignments.

Laboratory work : (At least 6- Performances - Any one from each Module)

Mechanics of Solids (Practical performance)		
Schedule	**Name of Experiment**	**Duration (Hours)**
1st week	1) Using UTM find different Moduli of a material or 2) The Tension Test on M S rod or 3) The Tension Test on M S Flat	2
3rd week	1) The Compression Test on Concrete cube or 2) The Compression Test on Timber or 3) The Compression Test on Brick	2
5th week	1) Test of Bending Using a Strain Guage or 2) Test of Bending Using a other electronic devices or 3) Test of Shear Stress in Beams	2
7th week	1) Using TorsionTesting Machine, verify the torsion equation, find different Moduli of a material. or 2) Spring Stiffness Test using strain gauges or other electronic devices	2
9th week	1) Charpy impact testing and Energy concept. or 2) Izod impact testing and Energy concept.	2
11th week	1) Using U T M perform experiments and verify Slope and deflection equations, 3 points and 4 points loading. (Performance) or 2) Deflection of Simply supported Beams (Performance) or 3) Deflection of Cantilever Beams (Performance)	2
Total Duration = 12 Hours		

Assignment:

(At least 1 from each module as per the Course instructor's guidelines; it is to be assessed during Laboratory hours. In order to avoid Copying/ repetition, Course Instructor may give different assignments to different groups.)

Mechanics of Solids		
Schedule	**Assignment**	**Duration (Hours)**
2nd week	**Stresses and strains in Elastic members, Spherical and Cylindrical shells** • Prepare a model of Cylindrical vessel or • Prepare a model of spherical vessel or • Prepare a model of Cylindrical vessel with hemispherical ends or • Prepare a chart showing diagrammatic representation of stresses or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MSExcel on how to find a particular quantity from given data (Ex: Find output, Elongation 'δ' from the input values of P,L,A and E) • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document – Appendix I)	2

4th week	**Axial force, shear force and bending moment diagrams for beams and portal frames** • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document) or • Prepare a chart showing AFD, SFD & BMD for different symmetric and asymmetric loads on S S beams or • Prepare a chart showing AFD, SFD & BMD for different loads on Cantilever beams	2
6th week	**Area Moment of Inertia, Bending stresses and Shear stresses in beams** • Prepare a chart showing MI @ XX, YY &ZZ axes passing through the centroid. or • Prepare 3D models of different typical cross sections of beams and find their cross sectional area, Ixx, Iyy and Izz.. or • Prepare charts showing typical cross sections and variation of Bending stresses and shear stresses across the cross section. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Flexural stress 'f' from the input values of P,L,I and E) • A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document)	2
8th week	**Torsion of Shafts, Columns** • Prepare 3D models of different solid and hollow circular cross sections of shafts and find their cross sectional area, Ixx, Iyy and Izz. or • A set of 5 questions on a module designed by course instructor, or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Shear stress 'q' or angle 'ϴ' from the input values of T,L,G and J) • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	2
10th week	**Principal planes and stresses, Strain Energy** • Draw typical stress transformation cases of Mohr's circle using graph paper. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of solids' (Example given at the end of this document)	2

12th week	**Slope and Deflection in Beams ; General Theorems** • Prepare chart to explain General theorems for slope and deflection. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	2
Total Duration = 12 Hours		

Appendix -I:

A chart about scientists and their contribution to the study of 'Mechanics of solids' be made by students. Contributions of Scientists like GiordanoRiccati, Leonhard Euler, Saint Venant, Christian Otto Mohr, William J M Rankine, Carlo Castigliano, EnricoBetti, Robert Hooke, W. H. Macaulay, Augustin- Louis Cauchy, Simeon Poisson can be studied and presented.

Important Websites:

1) http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/Material Testing Lab / MSE313A.pdf
2) https://home.iitm.ac.in/kramesh/Strength of Materials Laboratory Manual.pdf
3) https://www.researchgate.net/publication/338139499_Me_8381-Strength_Of_Materials_Lab_Manual

Assessment:

To be done in 13th week

- **Term Work:**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work-	:	15 Marks
Assignments-	:	10 Marks

The sum will be multiplied by a factor of attendance between 0.5 (for poor attendance) to 1 (very good attendance).

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus

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Semester- III		
Course Code	**Course Name**	**Credits**
CEL302	**Engineering Geology Lab. Practice**	**1**

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
-	2	-	-	1	-	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test-I	**Test-II**	**Average**						
-	-	-	-	3 hrs	25	-	25	50

Objectives

1. To acquire basic knowledge of Geological Lab practices and apply it for the safe development of Civil Engineering works.
2. To examine the mineral and rock sample and understand their fundamental properties for their evaluation as construction and foundation material.
3. To study the Geological maps and their sections in terms of selecting the sites for various civil engineering structures.
4. To study Borehole problems for determination of subsurface geology of the area.
5. To Study the drilling data and calculate RQD for assessment of rock masses for Civil Engineering purposes.

Outcomes

Learner will be able to…

1. Identify various rock forming minerals on the basis of physical properties.
2. Explain the characteristics of Igneous, Sedimentary and Metamorphic rocks and assess their suitability as construction material and foundation rock.
3. Interpret the rock characteristics and comment on their suitability as water bearing horizons.
4. Interpret the geological map and assess the suitability of the site for Civil Engineering works.
5. Solve the borehole problems and interpret it in order to understand subsurface Geology of the area.
6. Calculate RQD and evaluate the rock masses for Civil Engineering Works.

A) List of Experiments

Module	Detailed Contents	Lab Sessions/Hr
1	**Study of Physical Properties of Minerals:** Identification of common Rock forming minerals on the basis of physical Properties- **Silica Group:** Quartz and its varieties; Cryptocrystalline silica: Jasper and Agate; **Feldspar Group:** Orthoclase, Plagioclase; **Carbonate Group:** calcite; **Amphibole Group:** Asbestos, Actinolite and Hornblende; **Pyroxene Group:**Augite; **Mica Group:**Muscovite, Biotite and Talc; **Element Group:** Graphite.	6
2	Identification of Metallic minerals: Galena, Pyrite, Hematite, Magnetite.	2
3	**Identification of rocks:** **Igneous Rocks**-Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic Tuffs.	4
4	**Sedimentary Rocks-** Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites.	2
5	**Metamorphic Rocks-** Schist and its varieties, Gneiss and its varieties, Slate, Marbles, Quartzite and Phyllite.	2
6	**Geological Maps:** a) Horizontal strata: Drawing the cross section and assessment of geological history of the area. b) Inclined Strata: Calculation of dip and strike in an inclined strata and assessment of geological history of the area. c) Assessment of the geological conditions for a proposed dam site in the given map. d) Assessment of the geological conditions for a proposed tunnel site in the given map. e) Assessment of the geological conditions for groundwater reserve in the given map.	6
7	Borehole problems to interpret subsurface geology	2
8	Calculation of RQD from the given data and assessment of rock quality.	2

B) Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work Shall beas follows:

Laboratory work-	:	10 Marks
Assignments-	:	10 Marks
Attendance	:	05 Marks

- **End Semester Oral Examination**

Oral examination will be based on the entire syllabus.

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Semester- III

Course Code	Course Name	Credits
CEL 303	Architectural Planning & Design of Buildings Lab	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

@ For the course 'Building Design and Drawing, the oral examination shall be conducted in conjunction with the sketching examination.

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Course Objectives

1) To remember and recall the intricate details of building design and drawing.
2) To gain an understanding of the basic concepts of building design and drawing.
3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4) To identify, analyze, research literate and solve complex building design and drawing problems.
5) To have new solutions for complex building design and drawing problems.
6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes:

At the end of the course, learners will be able to:

1) Plan and design of residential and public building by implementing the principles of planning of buildings, Green building principles, byelaws, regulations and codes for planning

2) Preparing various working and detailed drawing of the buildings in CAD.
3) Preparing layouts of various building services.
4) Preparing perspective views for all types of buildings
5) Preparing the reports based on the drawings prepared, if required

Practical:

Students should make all the drawings during the Practical time allotted to them.

1) Drawings (Manually) should be drawn in the allotted Drawing hall only.
2) Drawings (CAD sheets) should be drawn on the Desktop/Laptop in Computational Lab.

After completing the work, Print out of those sheets should be submitted for gradation/Marks.

Assignments:

Two Assignments should be completed, covering all the modules in the syllabus.

1) Assignment-1 should be on 50% of the syllabus, to be completed before Internal Assessment-I exam.
2) Assignment-2 should be on the remaining 50% of the Syllabus, to be completed before Internal Assessment-II exam.

Site Visit:

Students should visit any Residential building/Public building physically and take Measurements inside of all rooms & over all outside of the building & can submit asmalldrawing sheet with the help of CAD. (**Optional** only)

Practical Examination (Oraland Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Term Work:

Drawings & Assignments:

1) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, Site plan, Foundation Plan and details of one FOOTING, Roof Plan ,schedule of opening and construction notes of a **residential building(bungalow or apartment)** to be constructed as a (G+1) R.C.C. framed structure **(only Manual Drawing)**
2) **One-Point** Perspective drawingfor any Residential structure(**only Manual drawing)**
3) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, schedule of opening and construction notes of a **public building(**Education/Health related) be constructed as a (G+1) R.C.C. framed structure (**only CAD drawing Sheet)**
4) **Two-Point** perspective drawing for any one public building (**only CAD drawing Sheet)**
5) Assignment No.- 1
6) Assignment No.- 2

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification acceptance of term-work warrants the satisfactorily the appropriate completion of the required quality & quantity of work for the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

	Particulars	**Marks**
1	Drawing Sheet (Manual)	7.5 Marks
2	Drawing Sheet (CAD Based)	7.5 Marks
3	Assignments	5 Marks
4	Attendance	5 Marks
	Total	**25 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% 80%: 03 Marks; 81% 90%: 04 Marks 91% onwards: 05 Marks **(Consider Practical attendance)**

Recommended Books:

- Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S.Y. Patki*(Tata McGraw-Hill Education)
- Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (MonojitChakraborti Publications, Kolkata)
- Planning and Designing Buildings by *Y. S. Sane* (Modern Publication House, Pune)
- Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C. V. Vijayan* (SPADES Publication, Calicut)
- Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

- IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
- National Building Code of India – 2005 (NBC 2005)
- Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)
- Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
- Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

- National Building Code of India, 2005
- IS 779-1978Specification for water meter
- IS 909-1975 Specification for fire hydrant
- IS 1172-1983 Code of basic requirement for water supply ,drainage & sanitation
- IS 1742-1983 code of practice for building drainage

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Semester- III

Course Code	Course Name	Credits
CEL304	Fluid Mechanics – I (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

The students will be able to learn:

1. The basic fluid mechanics concepts
2. Measuring pressure, velocity and discharge of fluid flow through pipes and channels

Course Outcomes:

At the end of the course, learner will be able to:

1. Calculate the metacentric height
2. Verify the Bernoulli's theorem
3. Determine the discharge coefficients
4. Measure fluid flow using various devices
5. Determine the hydraulic coefficients of an orifice

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Determination of the Metacentric height of a floating body	02 hrs
2	Investigating the validity of the Bernoulli equation applied to a steady flow of water through a tapered duct	04 hrs
3	Determination of coefficient of discharge of Venturimeter.	02 hrs
4	Determination of coefficient of discharge of Orifice meter.	02 hrs
5	Determination of coefficient of discharge of Nozzle meter.	04 hrs
6	Determination of coefficient of discharge of Notches (Rectangular and Triangular notch).	02 hrs
7	Determination of coefficient of discharge of weirs (Broad Crested weir and Ogee weir).	04 hrs
8	To determine the value of coefficient of contraction, coefficient of velocity and coefficient of discharge for the given orifice	04 hrs
9	Determination of coefficient of discharge of mouthpiece.	02 hrs

Assessment:

Term Work

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

End Semester Oral Examination

Oral examination will be based on entire syllabus.

Reference Books:

- Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
- Hydraulics and Fluid mechanics: Dr.P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
- Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
- Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
- Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
- Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

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Semester-III

Course Code	Course Name	Credits
CEL305	Skill Based Lab Course-I Computer Aided Drafting & Building Information Modelling	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	3	-	-	1.5	-	1.5

Theory					Term Work /Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

1. To enable the learners efficiently draft and label buildings components using the concepts of 2D and 3D drawing and detailing
2. To introduce the concepts of object-based modelling in 3-D environment to learners
3. To enable the learners to work on drawing and drafting softwares so that they can conveniently understand and design civil engineering components through the softwares.

Outcomes: Learner will be able to…

1. Transfer the plan from a drawing sheet to a 2-D drafting software
2. Visualize the various elements in the software like points, lines, polygons, etc. as objects of the real world and relate it with civil engineering components.
3. Apply civil engineering concepts to draft efficient civil engineering plans in accordance to various building bye laws and forms.
4. Conceptualize the space, logistic and statutory constraints in the real world to draw an efficient plan so that optimization is achieved
5. Attach and retrieve information pertaining to various civil engineering components through 3-D modelling software
6. Demonstrate a virtual walkthrough of buildings

C) **List of Experiments (Minimum Eight)**

Module	**Detailed Contents**	**Lab Sessions/Hr**
1	Listing out the various Computer Aided Drawing and Drafting (CADD) tools available for civil engineering projects in the market and highlighting the capabilities and advantages of each	03
2	Basic introduction to compatibilities, utilities and attributes of peculiar drafting softwares w.r.t their various commands, features, capabilities and functions.	03
3	Line plan of a residential structure using a CADD tool	03

4	Developed plan of a residential structure (mini um G+4) using a CADD tool	06
5	Developed plan of a public building using a CAD tool	06
6	Basic introduction to compatibilities, utilities and attributes of peculiar building information modelling (BIM) ftwares w.r.t their various commands, features, capabilities and func ons.	03
7	Creating families and basic models on BIM	06
8	Creating architectural plan on BIM of a G+1 bun low	03
9	Demonstrating a walkthrough on BIM for clients and presenting it	03
10	Clash detection and removal	03

D) Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 6 s tware generated sheets and one walkthrough presentation on BIM, distribution of marks for Term Work shall be as follows:

Laboratory work	:	30 Marks (comprising of minin um 6 software generated sheets)
Presentation	:	10 Marks (showing 3-D walk th ough the building)
Attendance	:	10 Marks

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Semester- III

Course Code	Course Name	Credits
CEM 301	Mini Project -1 A	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
- Marks awarded by guide/supervisor based on log book : 10
- Marks awarded by review committee : 10
- Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1) Quality of survey/ need identification
2) Clarity of Problem definition based on need.
3) Innovativeness in solutions
4) Feasibility of proposed problem solutions and selection of best solution
5) Cost effectiveness
6) Societal impact
7) Innovativeness
8) Cost effectiveness and Societal impact
9) Full functioning of working model as per stated requirements
10) Effective use of skill sets
11) Effective use of standard engineering norms
12) Contribution of an individual's as member or leader
13) Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1) Quality of problem and Clarity
2) Innovativeness in solutions
3) Cost effectiveness and Societal impact
4) Full functioning of working model as per stated requirements
5) Effective use of skill sets
6) Effective use of standard engineering norms
7) Contribution of an individual's as member or leader
8) Clarity in written and oral communication

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Second Year Civil Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	$3^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme										
Course Code	**Course Name**	**Internal Assessment**			**End Sem Exam**	**Exam Duration (Hrs.)-**	**Term Work**	**Prac. /Oral**	**Total**
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			**100**	**400**	-	**225**	**125**	**850**

Course Code	Course Name	Credits
CEC 401	Engineering Mathematics-IV	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite:

- Engineering Mathematics-I,
- Engineering Mathematics-II,
- Engineering Mathematics-III,

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to….

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Module	Detailed Contents	Hrs.
01	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self Learning Topics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	07
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	07
03	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	06
04	**Module: Probability Theory:** 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **Self- learning Topics:** Properties variance and covariance,	06
05	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) **Self -learning Topics:** Test of significance of large samples, Proportion test, Survey based project.	07
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA: One way classification, Two-way classification (short-cut method).	06

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- Question paper will comprise of total six questions, each carrying 20 marks
- Question 1 will be compulsory and should cover maximum contents of the curriculum
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four questions need to be solved.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
6. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

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<tr><th>Test-I</th><th>Test-II</th><th>Average</th></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>3 hrs</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
</table>

Rationale

Different components of civil engineering structures are subjected to variousforce systems and their combinations. For designing the components, these are analyzed for their response. The structural systems are determinate or indeterminate in nature and so there are different analysis methods.These will be learnt in this course. Subject knowledge of Engineering Mechanics and Mechanics of solids is the prerequisite of this course.

Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learner will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames and arches. These analyses will further be used while designing of Steel and RCC structures.

Objectives

1. To analyze for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams for Reactions, SF and B M in beams and axial forces in trusses and their application for rolling load systems.
3. To learn methods for evaluating rotation and displacement parameters in respect of frames andtrusses using various methods. To understand static and kinematic indeterminacy of structures.
4. To analyze the indeterminate structures using Flexibility methods and Using Clapeyron's Theorem..
5. To analyze the indeterminate structures such as beams & simple rigid jointed framesusing direct stiffness method.
6. To analyze the indeterminate structures using Moment Distribution as Stiffness method and Plastic analysis of structures.

Detailed Syllabus

Module		Course Modules / Contents	Duration
1		**Trusses and 3 hinged Arches**	**(9)**
	1.1	**Trusses**: Analysis of Perfect Coplanar Trusses by Method of Joints (3) Analysis of Perfect Coplanar Trusses by Method of sections.(3)	**6**
	1.2	**Three hinged elastic arches,** Determination of normal thrust, radial shear and bending moment for Symmetrical & Unsymmetrical parabolic three hinged arches.(3)	**3**
2		**Influence line diagrams and rolling loads**	**(09)**
	2.1	Influence lines for Reactions, shear force and bending moment at a section of cantilever, simply supported, overhanging beams without internal hinges. (2) Rolling loads, Determination of S F and BM at a section, Value and criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under rolling loads (UDL and series of point loads) for simply supported girder. (4)	**6**
	2.2	I L D for Axial forces in members of Pin jointed trusses (3)	**3**
3		**Determinate and Indeterminate structures**	**(8)**
	3.1	Deflection of Statically determinate structures, methods based on energy principles and Castigliano's theorems to evaluate deflection in portal frames, bent up and arch type structures. Application of Unit Load Method for calculating slope and deflection of a point on rigid jointed frames and deflection of a point on Pin jointed truss.	**5**
	3.2	Static and kinematic indeterminacies: Types of structures occurring in practice, their classification, linear and non-linear behavior of materials, geometric non-linearity, static and kinematic determinacy and indeterminacy of structure.	**3**
4		**Analysis of indeterminate structures by Flexibility method**	**(9)**
	4.1	Analysis of fixed beam. Application of Clapeyron's theorem of three moments to fixed beam and continuous beam.	**4**
	4.2	Flexibility coefficients and their use in formulation of compatibility equations. Application of flexibility method to propped cantilevers, fixed beams & continuous beams, Simple rigid jointed frames.	**5**
5		**Analysis of indeterminate structures by Stiffness method**	**(8)**
	5.1	**Direct stiffness method:** Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations.	**4**
	5.2	Application of Direct stiffness method to indeterminate beams & simple rigid jointed frames.	**4**
6		**Moment distribution method and Plastic Analysis of structures.**	**(9)**

	6.1	**Moment distribution method:** Application to indeterminate beams & simple rigid jointed frames & frame with inclined member but having only single translation degree of freedom including the effect of support settlement.	5
	6.2	**Plastic analysis of structures**: Introduction to plastic analysis, concept of plastic hinge, plastic moment carrying capacity, shape factor. Static and kinematic method of plastic analysis.Determination of collapse load for single and multiple span beams.	4

Contribution to Outcome

On completion of this course, the students will be able to:

1. Calculate axial forces in the Coplanartrusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Apply Flexibility methods and make use of Clapeyron's Theorem to analyze the indeterminate structures.
5. Analyse the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method.
6. Analyse the indeterminate structures using Moment Distribution as Stiffness method and make plastic analysis.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1) Question paper will comprise of total **six questions, each carrying 20 marks.**
2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4) Only **Four questions need to be solved**.

Recommended Books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, Vazirani and Ratwani

4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: HemantPatil, YogeshPatil, Jignesh Patel, Synergy Knowledgeware, Mumbai.
7. Strength of Materials: Rajput, S. Chand Publications, Delhi
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: DevdasMenon, Narosa Publishing House.
10. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, M. Vijyanand,
11. MagantiJanadharnand. I.K.International Publishing House Pvt. Ltd.
12. Comprehensive Structural Analysis: Vol-I and II by Vaidyanathan R: and Perumal R.LaxmiPublications.
13. Elementary Structural Analysis: Jindal
14. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
15. Fundamentals of Structural Analysis: Sujit Kumar Roy and SubrotaChakrabarty, S. Chand Publications.
16. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
17. Structural Analysis: Manmohan Das, Bharghab Mohan Pentice Hall International.

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norris and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall

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Semester- IV

Course Code	Course Name	Credits
CEC403	Surveying	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	100

Rationale

As it is always said “well begun is half done”. All civil engineering projects such as buildings, roads, bridges, railways, airports, dams, water treatment plants, sewage treatment plants begin with surveying. Knowledge of surveying is thus fundamental and very useful to all civil engineers. In this course, the students are well informed about the principles and methods of surveying. The students are made conversant with various instruments which are used in the field to take measurements for preparation of drawings. The course introduces the advancements in instruments and methods of surveying. The study deals with the methods of computing land areas and volume of earthworks. The course also covers horizontal and vertical curves.

Objectives

The students will be able to learn:

1. The basic principles and classification of surveying.
2. Various methods of measurements in surveying.
3. The appropriate techniques of surveying and skills of collecting field data for preparing drawings.
4. Advancements in instruments and methods of surveying.
5. The methods of computing areas and volumes using the site specific data for various purposes.
6. The setting out techniques of curves.

Detailed Syllabus

Module	Course Modules/ Contents		Periods
1	**Introduction**		5
	1.1	Definition, principles, objectives, fundamental classification-plane and geodetic.	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.	
	1.3	Bearings – Different types, compass – prismatic, surveyor, dip,declination and local attraction, compass traversing	
2	**Levelling and Contouring**		8
	2.1	Definitions, basic terms, types of instruments-dumpy level and Auto level, principal axes of dumpy level, temporary and permanent adjustments	
	2.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon,corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	2.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors,difficulties in levelling work, corrections and precautions work in levelling	
	2.4	Contouring: terms, contour, contouring, contour interval, horizontal equivalent Direct and indirect methods of contouring, interpolation of contours, uses of Contours and characteristics of contour lines. Grade contour	
3	**Theodolite Surveying**		8
	3.1	Various parts and axes of transit, technical terms, temporary and permanent adjustments of a transit, measurement of horizontal and vertical angles, Methods of repetition and reiteration.	
	3.2	Different methods of running a theodolite traverse, Latitudes and departures,rectangular coordinates,traverse adjustments by Bowditch's, transit and Modified transit rules, Gales Traverse Table, Numerical Problems.	
	3.3	Miscellaneous use of theodolite for various works such as prolongation of a straight line,setting out an angle, bearing measurements.Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing.	
4	**Indirect and Advanced Methods of Measurement**		7
	4.1	Tacheometry-Principle, Objective, Suitability and different methods of tacheometry, Stadia formula, Radial contouring , numerical on stadia method only	
	4.2	Electronic Distance Measurement: Working Principles, types, applications in surveying	
		Total Station- Working Principles, applications in surveying	
	4.3	Introduction to GPS	
	Plane Table Surveying, Areas and Volumes		5

5	5.1	Definition, principle, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying	
	5.2	Areas: Area of an irregular figure by trapezoidal rule, average ordinate rule,Simpson's 1/3 rule, various coordinate methods.Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	5.3	Volumes: Computation of volume by trapezoidal and prismoidal formula,volume from spot levels, volume from contour plans.	
6	**Curves**		**6**
	6.1	Horizontal Curves-Definitions of different terms, necessity and types of curves.Methods of setting out Simple circular curves- linear methods and Angular methods (Numericals on simple circular curves only)	
	6.2	Vertical curves– Definitions, geometry and types. Tangent correction and chord gradient methods.	
		Total	**39**

Contribution to Outcomes

After completion of the course, the learner will be able to:

1. 1.Apply the principles of surveying and field procedures to conduct the various surveys
2. Use various methods for taking linear and angular measurements
3. Collect, record and analyse the field data for preparing drawings.
4. Explain the advancements in instruments and methods
5. 5.Calculate the area of land and volume of earthwork
6. Set out curves

Internal Assessment (20 marks):
Consisting **Two Compulsory Class Tests:**
First test based on approximately 40% of the contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

1. The question paper will consist of **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory**and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature**(for example if Q.2 has part (a) from module 3 then part (b) will be from any other module other than module 3)
4. Only**Four questions need to be solved.**

Recommended Books:

1. Surveying and Levelling: R. Agor, Vol. -I, 11th Edition, Khanna Publishers (ISBN8174092358)

2. Surveying and Levelling:Kanetkar and Kulkarni, Vol. -I, 24th Edition, Pune Vidyarthi Griha, Pune. (ISBN 8185825114)
3. Surveying and Levelling:Dr. B.C. Punmia, Vol.-I, 16th Edition, Vol. -II 4th Edition, Laxmi Publications (ISBN9788170088530)
4. Surveying and Levelling: N NBasak, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)

Reference Books:

1. Surveying: Volume -I: Dr K.R. Arora, Standard Book House.
2. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
3. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata McGraw Hill
4. Textbook of Surveying, C Venkatramaiah, University Press, Hyderabad, Latest Edition
5. Fundamentals of Surveying, S.K. Roy, Prentice Hall India, New Delhi
6. Surveying for Engineers, John Uraine and Bill Price, Palgrave Macmillan
7. Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill

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Semester - IV

Course Code	Course Name	Credits
CEC 404	Building Materials & Concrete Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03		-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	---	100

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This course provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting and curing. This course is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building materials and concrete technology so that student can effectively execute quality control during building construction work.

Objectives

1. To identify the good and significant materials to be used for the construction work and their associated quality, durability, warrantees, and availability.
2. To study the manufacturing process, properties and use of different types of building materials like stone, brick, glass, timber and the materials such as paints and varnishes used for the treatment of surfaces so as to achieve good knowledge about the building materials.
3. To acquire a thorough knowledge about the properties and significance of different materials used for the manufacturing of concrete.
4. To study the properties, test conducted and significance of concrete in terms of properties of fresh and hardened concrete.
5. To understand the concept and optimization of mix design of concrete for different exposure conditions.
6. To enable the students to understand the mechanized and precise procedure of concrete production in Ready Mix Plants. To understand the basic non-destructive tests conducted on concrete to check the in place strength and durability of concrete.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Introduction to building materials and concrete:**	03
	1.1	**Introduction to building materials:** Introduction, role of materials in construction, classification of materials, economical and durable materials.	
	1.2	**Introduction to concrete:** History of concrete, necessity, limitations, merits and demerits.	
2		**Building Materials:**	09
	2.1	**Stones:** Classification and properties of building stones, relation to their structural requirements, quarrying, dressing, seasoning and preservative treatments.	
	2.2	**Bricks and blocks:** Burnt clay bricks: raw materials, manufacturing processes, classification, properties, defects, tests as per BIS codes. Bricks for special use: refractory bricks. Concrete blocks, Paver block, Autoclaved Aerated Concrete (AAC) blocks, Cellular Light Weight Concrete (CLC) blocks and ceramic tiles: raw materials, manufacturing process and properties.	
	2.3	**Glass:** Properties, types, uses.	
	2.4	**Timber:** Types of natural wood and artificial wood, preservative treatments, defects in timber, wood products and wood composites.	
	2.5	Damp proofing, water proofing materials and Termite proofing.	
	2.6	**Mortar:** Types, ingredients, proportions and suitability.	
	2.7	**Paints, Enamels and Varnishes:** Composition. Painting on: plastered surfaces, wood surfaces, meta l surfaces. Effect of weather on: Enamels, distemper, white wash and colour wash, varnish, French polish, Wax Polish.	
	2.8	**Miscellaneous Materials:** Gypsum, Plaster of Paris, Heat and sound insulating materials.	
3		**Constituent of Concrete:**	09
	3.1	**Fine and Coarse Aggregates:** Classification, physical and mechanical propertiesand their influence on the properties of concrete, gradation, Alkali aggregate reaction. Properties of manufacturing sand.	
	3.2	**Cement (OPC):** Grades, Manufacturing, Chemical composition, Hydration of cement, Physical properties as per BIS code. Effects of chemical constituents on the properties of cement. Different types of cement: Chemical composition, properties as per relevant IS codes and their applications.	
	3.3	**Water:** Desiredquality of water for concrete.	
	3.4	**Lime:**Types and their usages.	
	3.5	**Admixtures:** Definition and purposes, types of mineral and	

		chemical admixtures. Test on admixtures: chemistry and compatibility with concrete.	
4	**Concrete:**		06
	4.1	Grades, manufacturing process, preparation of batch report, Duff Abram's W/C ratio law & its significance.	
	4.2	Properties of fresh and hardened concrete, factors affecting of workability, vibration of concrete, Types of vibrators: Internal, external, surface and table vibrators.	
	4.3	Durability: factors affecting durability, relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test (RCPT).	
5	**Concrete Mix Design:**		08
	5.1	Definition and objectives, Types of mix as per IS:456, Mix design for compressive strength and flexural strength in accordance with IS 10262 and IS 456.	
	5.2	Methods of Curing of concrete, Methods of determining compressive Strength of accelerated-cured concrete test specimens as per IS 9013, Calculation of ingredients of concrete for batching as per concrete mix proportions for different grades.	
6	**Concreting Methods and Test**		04
	6.1	**Ready Mixed Concrete:** Advantages of RMC, Components and Lay-out of RMC plant. Distribution and Transport, Handling and Placing. Codes recommendations.	
	6.2	**Non-Destructive Testing:** Need, application and limitation, Schmidt Rebound hammer test, Ultrasonic Pulse Velocity test.	

Contribution to Outcome

On completion of this course, the students will be able to:

1. To develop and implement the conceptual knowledge of building materials in the construction industry.
2. Assess the properties of building stones and their classifications. Understand the concept of various methods of manufacturing of bricks and different types of concrete blocks.
3. To expose students to various quality control aspects of civil engineering materials by performing different lab tests on materials.
4. Identify the ingredients and properties of fresh and hardened concrete.
5. To interpret and design concrete mix for various grades for various exposure conditions.
6. To study the new technology for manufacturing, testing and quality of concrete.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be compulsory and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2. Building Construction: *S.P. Arora, Dr.S.P. Bindra,*DhanpatRai Publication, New Delhi.
3. Building Construction: *Dr. B.C. Punmia, A.K.Jain, A.R.Jain,*Laxmi Publication., New Delhi.
4. Concrete Technology Theory and Practice: *M.S. Shetty, S.*Chand Publication.
5. Concrete Technology: *M.L. Gambhir,* Tata McGraw Hill, NewDelhi.
6. Concrete Technology: *A.M. Neville & J. J. Brooks.,* ELBS-Longman.
7. Concrete Technology: *A.M. Neville & Isaac Pitman,* London.
8. Concrete Technology: *A. R. Shanthakumar,* Oxford University Press.
9. Materials of Construction: *D. N. Ghose,* Tata McGraw Hill, Delhi.
10. Building Materials: *S.K. Duggal,* New Age International Publishers.
11. Concrete Technology: *D. F. Orchardi,* Wiley, 1962.
12. Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1. Engineering Materials: *S.R. Rangwala,*Charotar Publications.
2. Architectural Materials science: D. Anapetor, Mir Publishers.
3. Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4. Engineering Materials: P. Surendra Singh, Vani Education Books,New Delhi.
5. Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal,McGraw Hill Publications.
6. Properties of concrete: Neville, Isaac Pitman, London.
7. NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEC405	Fluid Mechanics - II	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	100

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study deals with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

The students will be able to learn:

1. The knowledge of closed conduit flows, determine various losses through pipes, Pipe network and Water hammer effect
2. Theory of Laminar flow and Turbulent flow,
3. Understand the concept of Boundary Layer theory, flow separation and forces around submerged bodies
4. Application of moment of momentum principle on pipe bends and sprinklers
5. The importance of dimensionless numbers, dimensional analysis and similarities.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1	**Flow through pipes**		14
	1.1	**Flow through pipes:** Loss of head through pipes, Darcy-Weisbach equation, Major and minor losses. Hydraulic gradient line and Total energy gradient line, pipes in series,equivalent pipes, pipes in parallel, flow through laterals, flow through Branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer:** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures	

	1.3	**Flow through nozzles:** Power transmitted through nozzle, condition for maximum power transmitted,diameter of nozzle for maximum transmission of power	
2	**Laminar Flow**		05
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving.		
3	**Turbulent Flow**		04
	Causes of turbulence, shear stress in turbulent flow, Reynolds's stresses, Prandtl's mixing length Theory, Hydro dynamically smooth and rough boundaries, velocity distribution in smooth and rough pipes, Karman-Prandtl's velocity distribution equation.		
4	**Boundary Layer Theory**		07
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerged body, drag and lift, terminal velocity of body, Magnus Effect.		
5	**Dynamics of Fluid Flow**		04
	Momentum principle, Moment of momentum principle (applications: Pipe bends and sprinklers).		
6	**Dimensional Analysis**		05
	Dimensional homogeneity, Buckingham's π theorem, Rayleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynolds's model law, Froude's model law, Euler's Model law, Weber's Model law, Mach model law, scale effect in models.		
Total			39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

1. Analyze flow through pipes, various losses through pipes, pipe network and power transmission through nozzle
2. Explain the concept of Laminar flow and velocity distribution through parallel plates and pipes
3. Explain the concept of Turbulent flow and velocity distribution in pipes
4. Describe boundary layer concept , boundary layer separation and flow around submerged bodies
5. Apply Moment of Momentum Principle

6. Explain the importance of dimensionless numbers, dimensional analysis and similarity behavior of model and prototype

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

First test based on approximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Recommended Books:

1. Hydraulics and Fluid mechanics: Dr P.M. Modi and Dr. S.M. Seth, Standard book House, Delhi
2. Theory and Application of Fluid Mechanics: K. Subramanya, Tata McGraw hill publishing company
3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
5. Fluid Mechanics and Hydraulics: Dr. S. K. Ukarande, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN97893 8116 2538
6. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli. Oxford HigherEducation.

Reference Books:

1. Fluid Mechanics: Frank M. White, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: Streeter White Bed ford, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: R.L. Daugherty, J.B.Franzini, E.J.,Finnemore, TataMcGraw Hill New Delhi.
4. Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India Pvt. Ltd.,Delhi.

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Semester- IV

Course Code	Course Name	Credits
CEL401	Structural Analysis Tutorial	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives:

1. To analyse for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams and rolling loads.
3. To learn methods for evaluating rotation and displacement of frames and trusses.
4. To analyse the indeterminate structures using Flexibility methods and Stiffness methods.
5. To understand Plastic analysis.

Outcomes:

On completion of this course, the students will be able to:

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Analyse the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.

List of Tutorials and Assignments		
Week (Activity)	**Content**	**Hours**
1st week (Tutorial)	Analysis of Trusses and Three hinged elastic arches (Numericals based on this Module will be solved in tutorial room.)	2

2nd week (Assignments)	1) Analysis of Trusses and Three hinged elastic arches 2) Solve set of questions given by the course instructor or 3) Write a report on use of arches in civil engineering or 4) Difference in behaviour of trusses and arches if used in bridges or 5) Write a report on limitations of trusses /arches or 6) Report Famous Truss structures / arch structures in world or 7) 6 Write a report on use of trusses in Civil Engineering	2
3rd week (Tutorial)	Influence line diagrams and rolling loads (Numericals based on this Module will be solved in tutorial room.)	2
4th week (Assignments)	Influence line diagrams and rolling loads 1) Solve set of questions given by the course instructor or 2) Write a report on use of arches in civil engineering or 3) Design an experiment for ILD of reactions of beam. or 4) Design an experiment for ILD of axial forces of a multi-bay truss. or 5) write a report on IRC and classes of rolling loads	2
5th week (Tutorial)	Determinate and Indeterminate structure (Numericals based on this Module will be solved in tutorial room.)	2
6 th week (Assignments)	Determinate and Indeterminate structure 1) Solve set of questions given by the course instructor or 2) Prepare a chart explaining static and kinematic indeterminacy or 3) Write a computer program in C++ or MS-excel or similar for ILD of reactions. or 4) Write a computer program in C++ or MS-excel or similar for ILD for axial forces in Truss members.	2
7th week (Tutorial)	Analysis of indeterminate structures by Flexibility method (Numerical based on this Module will be solved in tutorial room.)	2
8th week (Assignments)	Analysis of indeterminate structures by Flexibility method 1) Solve set of questions given by the course instructor or 2) Prepare a poster on Flexibility and Stiffness approach or 3) Solve a set of 4-5 questions given by the course instructor on Flexibility methods and validate the same using relevant Structural Analysis or design software.	2
9th week (Tutorial)	Analysis of indeterminate structures by Direct stiffness method (Numericals based on this Module will be solved in tutorial room).	2
10th week (Assignments)	Analysis of indeterminate structures by Direct stiffness method 1) Solve set of questions given by the course instructor or 2) Write a report on Stiffness methods in civil engineering or 3) Prepare a poster on Clapeyron's theorem for continuous beam.or 4) Solve a set of 4-5 questions given by the course instructor on Direct stiffness method and validate the same using relevant Structural Analysis or design software.	2

11th week (Tutorial)	Moment distribution method, Plastic analysis of structures (Numerical based on this Module will be solved in tutorial room.)	2
12th week (Assignments)	Moment distribution method, Plastic analysis of structures 1) Solve set of questions given by the course instructor or 2) Write a report on Plastic analysis of structures or 3) Solve a set of 4-5 questions given by the course instructor on Moment distribution method and validate the same using relevant Structural Analysis or design software.	2
13th week	Viva-Voce Examination	2

- **Assessment:**

Term Work: Term work will include Tutorial work and Assignments both, Distribution of marks for Term Work shall be as follows:

Tutorial work-	:	15 Marks
Assignments-	:	10 Marks
Total Term work	:	25 Marks
Attendance	:	Apply multiplying Factor 0.5 to 1.0 to the above total.

End Semester Oral Examination

Oral examination will be based on entire syllabus.

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Semester- IV

Course Code	Course Name	Credits
CEL402	Surveying(Lab)	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	25	75

@ For the course "Surveying (Lab)" the oral examination shall be conducted in conjunction with the practical conduction.

Course Objectives:

The students will be able to learn:

1) Various surveying instruments, their least counts, various parts and suitable uses.
2) Methods of measurements in the field.
3) Skills for collecting, recording and analysing the field data.
4) Advanced instruments and methods.
5) First hand practical experience by receiving field exposure to collect site specific data.
6) Setting out techniques.

Course Outcomes:

At the end of the course, learner will be able to:

1) Operate and use the surveying instruments according to the accuracy and suitability.
2) Measure linear and angular dimensions in horizontal and vertical planes.
3) Collect, record and analyse the field data systematically.
4) Prepare plans of the existing features on the ground, sections and contours.
5) Compute the area of land and the volume of earthwork.
6) Set out curves and foundation plans.

List of practical's and projects:

Perform minimum **six** practical's out of 01 to 10 and all the projects are **mandatory**

Module	**Detailed Contents**	**Lab Sessions/Hr**
1	Chain and cross staff surveying.	03 hrs
2	Measuring bearings of a closed traverse with prismatic compass and computation of interior angles.	03 hrs
3	Simple and compound levelling	03 hrs
4	Measurement of horizontal and vertical angles.	03 hrs
5	Finding constants, heights and distances using tachometry.	03 hrs
6	Measurement of distances, bearings and area using total station.	03 hrs
7	Plane Table Surveying by intersection method.	03 hrs
8	Find an area of irregular figure using a conventional planimeter and verify it using a digital planimeter.	03 hrs
9	Setting out a simple curve by Rankine's method.	03 hrs
10	Setting out a simple foundation plan.	03 hrs
Projects		
A survey camp of three days is to be arranged to execute the following projects for undergoing the students through practical instructions in civil engineer's career with the actual field exposure at an ideal site location .		
1	**Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, profile levelling, cross-sectioning at 20m interval,, plotting of 'L' section and 'C' section. (Two full imperial sheets, the first sheet with key plan and 'L' section and the second sheet covering any three typical Cross-sections)	
2	**Project II:** Block Contouring project using Auto level for minimum 60 m × 60 m area and generating contours by MS Excel. (Take contour interval as 0.2 meter)	
3	**Project III:**Tachometric contouring project on a hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours by taking contour intervals as 1 meter.	

Assessment:

Teamwork

Including above practical work, projects and assignments, distribution of marks for Term Work shall be as follows:

Practical Work-	:	15 marks
Assignments -	:	05 marks
Attendance-	:	05 marks
Projects-		
Field work	:	15marks
Office work (Drawings)	:	10marks
Total	:	**50marks**

- **End Semester Practical/ Oral Examination**

Practical Examination : 10 Marks

Oral Examination : 15 Marks.

Oral examination will be conducted after conduction of practical examination & it will be based on term work & Practical examination

Reference Books:

1) Surveying and Levelling : *R. Agor, Vol-I, 11th Edition*, Khanna Publishers (ISBN 8174092358)
2) Surveying and Levelling :*Kanetkar and Kulkarni,*Vol-I, 24th Edition, Pune VidyarthiGriha, Pune. (ISBN 8185825114)
3) Surveying and Levelling : *Dr. B.C. Punmia,* Vol.-I, 16th Edition, Vol -II 4th Edition, Laxmi Publications (ISBN9788170088530)
4) Surveying and Levelling: *N NBasak*, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)
5) Surveying: Vol-I: Dr K.R. Arora, Standard Book House.
6) Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
7) Surveying and Levelling (Vol.-I): S.K. Duggal, Tata Mc-Graw Hill

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Semester- IV

Course Code	Course Name	Credits
CEL 403	Building Materials & Concrete Technology (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives:

1) To determine physical and mechanical properties of materials used in the manufacturing of concrete like cement and aggregates.
2) To test the physical attributes and mechanical strength of burnt clay bricks used in the construction of structures.
3) To determine the various properties of fresh and hardened concrete with and without the addition of admixtures.
4) To study the different basic non-destructive tests conducted in the laboratory or on site to determine the durability and strength of existing concrete structures.
5) To utilize the knowledge of mix design in the manufacturing of concrete, in the laboratory.
6) To test the physical attributes and mechanical strength of timber and tiles used in the construction of various components of the structure.
7) To understand the practical scenario of the commonly used building materials in terms of their availability, cost and significance through market surveys.

Outcomes: Learner will be able to…

1) Develop collaborative skills to work in a team/group
2) Test physical properties of cement, aggregates and concrete.
3) Test various other building materials like tiles, bricks and timber
4) Evaluate the effects of admixtures on physical properties of concrete.
5) Design the concrete mix.
6) To bridge the gap between theoretical and market/industrial practices by market surveys.

List of Experiments (first seven are compulsory)

Module	Detailed Contents	Lab Sessions/Hr
1	Physical properties of OPC: Physical test, Fineness, Standard consistency, Soundness, Setting time, Compressive strength.	**02/04**
2	Physical Properties of Fine and Course Aggregates: Specific gravity, bulk density, Moisture content, Water absorption, flakiness index, elongation index, Fineness modulus, Silt content and bulking of sand	**02/04**
3	Tests on burnt clay bricks	**01/02**
4	Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table) and strength of concrete	**02/04**
5	Study of admixtures and their effect on workability and strength of concrete.	**01/02**
6	Non-destructive testing of concrete: Rebound hammer and ultrasonic pulse velocity	**01/02**
7	Concrete mix design in the laboratory	**01/02**
8	Test on tiles(optional)	**01/02**
9	Compression test on timber (Parallel/ perpendicular to the grains). (optional)	**01/02**
10	Market survey on common building materials (optional)	**01/02**

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall prepare a report of the visit and the same shall be evaluated by the concerned teacher.

Assessment:

The term work shall consist of:

- Report of experiments performed.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of market surveys and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Individual Practical performance	:	07 Marks
Assignments	:	03 Marks
Reports of experiment	:	05 Marks

Site Visit/Industrial visit	:	05 Marks
Attendance	:	05 Marks
Total	:	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted tom75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Practical/Oral Examination

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practical conducted by the students and a detail report of the industrial/ site visit.

Recommended Books:

1) A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2) Building Construction: S.P. Arora, Dr.S.P. Bindra,DhanpatRai Publication, New Delhi.
3) Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain,Laxmi Publication., New Delhi.
4) Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication.
5) Concrete Technology: M.L. Gambhir, Tata McGraw Hill, NewDelhi.
6) Concrete Technology: A.M. Neville & J. J. Brooks., ELBS-Longman.
7) Concrete Technology: A.M. Neville & Isaac Pitman, London.
8) Concrete Technology: A. R. Shanthakumar, Oxford University Press.
9) Materials of Construction: D. N. Ghose, Tata McGraw Hill, Delhi.
10) Building Materials: S.K. Duggal, New Age International Publishers.
11) Concrete Technology: D. F. Orchardi, Wiley, 1962.
12) Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1) Engineering Materials: *S.R. Rangwala,* Charotar Publications.
2) Architectural Materials science: D. Anapetor, Mir Publishers.
3) Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4) Engineering Materials: P. Surendra Singh,Vani Education Books, New Delhi.
5) Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal, McGraw Hill Publications.
6) Properties of concrete: Neville, Isaac Pitman, London.
7) NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEL404	Fluid Mechanics – II (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

The students will be able to learn:

1) to verify the basic fluid mechanics concepts experimentally
2) the fluid flow pattern in pipes
3) to estimate the losses in pipe flow
4) the velocity distribution in pipes

Course Outcomes:

At the end of the course, learner will be able to:

1) Verify the Reynold's experiment
2) Estimate the viscosity of fluid
3) Calculate the losses in pipes
4) Assess the flow pattern and velocity distribution in pipe flow
5) learn the water hammer phenomenon through demonstration
6) learn the wind tunnel testing through demonstration

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Study of different types of flow using Reynold's apparatus	02 hrs
2	Determination of viscosity of fluid	02 hrs
3	Estimation of the head loss due to friction incurred by a fluid along a pipeline (To find the friction factor for the given pipes of different sizes)	04 hrs
4	To determine different losses in pipe fittings (Estimation of the minor losses)	04 hrs
5	Laminar flow through pipes	02 hrs
6	Velocity distribution in circular pipes	04 hrs
7	Turbulent flow through pipe	02 hrs
8	Study of Water Hammer phenomenon	04 hrs
9	Study of wind tunnel	02 hrs

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work-	:	15 Marks
Assignments-	:	05 Marks
Attendance	:	05 Marks

- **End Semester Oral Examination**

Reference Books:

1) Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
2) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
3) Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
4) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
5) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
7) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

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Semester- IV

Course Code	Course Name	Credits
CEL405	Skill Based Lab Course-II Total Station and Geographical Information System	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	2	-	-	1	-	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

1) To enable the learners, operate the Total Station and generate its output in terms of plans, elevations and 3D views
2) To enable the learners, operate the Global Navigation Satellite System (GNSS) receivers and retrieve the information
3) To enable the learners work on a Geographical Information System (GIS) platform for assimilating geographical data

Outcomes: Learner will be able to…

1) Operate a Total Station and traverse the field
2) Perform various operations like computing height of a structure, computing area of plot, subdividing area, demarcating boundaries, etc. Using Total Station
3) Set out foundation plan using Total Station
4) Compute the point, line and area features using Global Navigation Satellite System
5) Plot various existing features in a geographic area on a GIS platform
6) Add attribute and perform various statistical operations in GIS

List of Experiments (Minimum Eight)

Module	Detailed Contents	Lab Sessions/Hr
1	Introduction to concepts, fundamental features and working principal of Total Station (TS)	02
2	Temporary settings of a TS in field and perform basic functions on	02

	total station like traversing, area of open plot, height calculations, etc.	
3	Collect detailed features of a plot (comprising features such as 2-3 buildings, courtyards, security cabins, playgrounds, trees, gates, poles, roads, drainage lines, etc.) using TS	04
4	Transfer data collected through TS on a convenient computer aided drafting (CAD) software	02
5	Feeding a CAD plan in TS and setting out a foundation plan using TS	02
6	Introduction to fundamental features of Global Navigation Satellite System (GNSS) and collect point, line and polygon features through a GNSS receiver	02
7	Computing latitudes, longitudes, altitudes of points, length of roads, area of plots, etc. using a GNSS system	02
8	Basic introduction to compatibilities, utilities and attributes of peculiar Geographical Information System (GIS) softwares available in market w.r.t their various commands, features, capabilities and functions.	02
9	Collecting ground points through GNSS and TS for integrating it with spatial data obtained from a GIS platform like google earth, openstreetnetwork, etc. and developing a model on a GIS software	04
10	Add various layers in term of attributes and perform various statistical operations and queries in GIS	04

Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 8 software generated sheets distribution of marks for Term Work shall be as follows:

Laboratory work	:	40 Marks (comprising of min 8 software generated sheets: 4 using TS and GNSS data in CADD tool and 4 using GIS tool)
Attendance	:	10 Marks

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Semester- IV

Course Code	Course Name	Credits
CEM 401	Mini Project -1B	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

1) To acquaint with the process of identifying the needs and converting it into the problem.
2) To familiarize the process of solving the problem in a group.
3) To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4) To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1) Identify problems based on societal /research needs.
2) Apply Knowledge and skill to solve societal problems in a group.
3) Develop interpersonal skills to work as member of a group or leader.
4) Draw the proper inferences from available results through theoretical/ experimental/simulations.
5) Analyse the impact of solutions in societal and environmental context for sustainable development.
6) Use standard norms of engineering practices
7) Excel in written and oral communication.
8) Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9) Demonstrate project management principles during project work.

Guidelines for Mini Project

1) Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2) Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3) Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4) A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

5) Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
6) Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7) Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8) The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9) With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10) However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05
    -

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.

- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1) Quality of survey/ need identification
2) Clarity of Problem definition based on need.
3) Innovativeness in solutions
4) Feasibility of proposed problem solutions and selection of best solution
5) Cost effectiveness
6) Societal impact
7) Innovativeness
8) Cost effectiveness and Societal impact
9) Full functioning of working model as per stated requirements
10) Effective use of skill sets
11) Effective use of standard engineering norms
12) Contribution of an individual's as member or leader
13) Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1) Quality of problem and Clarity
2) Innovativeness in solutions
3) Cost effectiveness and Societal impact
4) Full functioning of working model as per stated requirements
5) Effective use of skill sets
6) Effective use of standard engineering norms
7) Contribution of an individual's as member or leader
8) Clarity in written and oral communication

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R19- TE

University of Mumbai

No. AAMS (UG)/74 of 2021-22

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/44 of 2018-19 dated 25th June, 2018 relating to the revised syllabus as per the (CBCS) for T.E. in Civil Engineering (Sem – V & VI).

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 27th April, 2021 and subsequently made by the Board of Deans at its meeting held on 11th June, 2021 vide item No. 6.2 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 6.2 (R) and that in accordance therewith, the revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Civil Engineering (T.E. - Sem. V & VI) has been brought into force with effect from the academic year 2021-22. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
30th September, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.2/29/06/2021

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No. UG/74 -A of 2021-22 MUMBAI-400 032 30th September, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

AC-29/06/2021

Item No.-6.2

UNIVERSITY OF MUMBAI

मुंबई विद्यापीठ

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-2021

Third Year with Effect from AY 2021-2022

Final Year with Effect from AY 2022-2023

(REV-2019 'C' Scheme) from Academic Year 2019-2020

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019-2020)

Syllabus for Approval

Title of the Course	:	Third Year in Bachelor of Civil Engineering
Eligibility for Admission	:	After Passing First Year Engineering as per the Ordinance 0.6242
Passing Marks	:	40%
Ordinances / Regulations (if any)	:	Ordinance 0.6242
No. of Years / Semesters	:	8 semesters
Level	:	Under Graduation
Pattern	:	Semester
Status	:	New
To be implemented from Academic Year	:	With effect from Academic Year: 2021-2022

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Third Year of Engineering from the Academic year 2021-22. Subsequently this will be carried forward for Final Year Engineering in the academic years 2022-23.

Dr. S. K. Ukarande	**Dr Anuradha Muzumdar**
Associate Dean	Dean
Faculty of Science and Technology,	Faculty of Science and Technology,
University of Mumbai, Mumbai	University of Mumbai, Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 "C" scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-graduate studies
4. To motivate learners for life-long learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering University of Mumbai			
Dr. S. K. Ukarande	Chairman	Dr. V. Jothiprakash	Member
Dr. D.D. Sarode	Member	Dr. K. K. Sangle	Member
Dr. S. B. Charhate	Member	Dr. D. G. Regulawar	Member
Dr. Milind Waikar	Member	Dr. A. R. Kambekar	Member
Dr. R.B. Magar	Member	Dr. Seema Jagtap	Member

Undergraduate Program Structure for Second year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2020-2021)
Semester – III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics – III	03	-	01	03	-	01	04
CEC302	Mechanics of Solids	04	-	-	04	-	-	04
CEC303	Engineering Geology	03	-	-	03	-	-	03
CEC304	Architectural Planning & Design of Buildings	02	-	-	02	-	-	02
CEC305	Fluid Mechanics – I	03	-	-	03	-	-	03
CEL301	Mechanics of Solids	-	02	-	-	01	-	01
CEL302	Engineering Geology	-	02	-	-	01	-	01
CEL303	Architectural Planning & Design of Buildings	-	02	-	-	01	-	01
CEL304	Fluid Mechanics – I	-	02	-	-	01	-	01
CEL305	Skill Based Lab Course – I	-	03	-	-	1.5	-	1.5
CEM301	Mini Project – 1A	-	03$	-	-	1.5	-	1.5
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC301	Engineering Mathematics –III	20	20	20	80	03	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	03	-	-	100
CEC303	Engineering Geology	20	20	20	80	03	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	03	-	-	100
CEC305	Fluid Mechanics – I	20	20	20	80	03	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics – I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course – I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1A	-	-	-	-	-	50	-	50
Total		**100**			**400**	-	**225**	**100**	**825**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Second year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2020-2021)
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics – IV	03	-	01	03	-	01	04
CEC402	Structural Analysis	04	-	-	04	-	-	04
CEC403	Surveying	03	-	-	03	-	-	03
CEC404	Building Materials & Concrete Technology	03	-	-	03	-	-	03
CEC405	Fluid Mechanics-II	03	-	-	03	-	-	03
CEL401	Structural Analysis	-	02	-	-	01	-	01
CEL402	Surveying	-	03	-	-	1.5	-	1.5
CEL403	Building Material Concrete Technology	-	02	-	-	01	-	01
CEL404	Fluid Mechanics-II	-	02	-	-	01	-	01
CEL405	Skill Based lab Course – II	-	02	-	-	01	-	01
CEM401	Mini Project – 1B	-	03$	-	-	1.5	-	1.5
Total		**16**	**14**	**01**	**16**	**07**	**01**	**24**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125
CEC402	Structural Analysis	20	20	20	80	03	-	-	100
CEC403	Surveying	20	20	20	80	03	-	-	100
CEC404	Building Materials & Concrete Technology	20	20	20	80	03	-	-	100
CEC405	Fluid Mechanics-II	20	20	20	80	03	-	-	100
CEL401	Structural Analysis	-	-	-	-	-	25	25	50
CEL402	Surveying	-	-	-	-	-	50	25	75
CEL403	Building Material Concrete Technology	-	-	-	-	-	25	25	50
CEL404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL405	Skill Based lab Course - II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1B	-	-	-	-	-	25	25	50
Total		**100**			**400**	-	**225**	**125**	**850**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2021-2022**)
Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC501	Theory of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC502	Applied Hydraulics	03	-	-	03	-	-	03
CEC503	Geotechnical Engineering-I	03	-	-	03	-	-	03
CEC504	Transportation Engineering	04	-	-	04	-	-	04
CEDLO501X	Department Level Optional Course-1	03	-	-	03	-	-	03
CEL501	Theory of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL502	Applied Hydraulics	-	02	-	-	01	-	01
CEL503	Geotechnical Engineering-I	-	02	-	-	01	-	01
CEL504	Transportation Engineering	-	02	-	-	01	-	01
CEL505	Professional Communication and Ethics-II	-	02^{*}+2	-	-	02	-	02
CEM501	Mini Project – 2A	-	$04^{\$}$	-	-	02	-	02
Total		**16**	**16**	**-**	**16**	**08**	**-**	**24**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC501	Theory of Reinforced Concrete Structures	20	20	20	80	03	-	-	100
CEC502	Applied Hydraulics	20	20	20	80	03	-	-	100
CEC503	Geotechnical Engineering-I	20	20	20	80	03	-	-	100
CEC504	Transportation Engineering	20	20	20	80	03	-	-	100
CEDLO501X	Department Level Optional Course -1	20	20	20	80	03	-	-	100
CEL501	Theory of Reinforced Concrete Structures	-	-	-	-	-	25	25	50
CEL502	Applied Hydraulics	-	-	-	-	-	25	25	50
CEL503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Professional Communication and Ethics-II	-	-	-	-	-	25	25	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
Total		**100**			**400**	**-**	**150**	**150**	**800**

*** Theory class to be conducted for full class**

$ indicates work load of Learner (Not Faculty), for Mini Project

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2021-2022)
Semester - V

Department Level Optional Course – 1

Sr. No.	Course Code CEDLO501X	Department Level Optional Course – 1
1	CEDLO5011	Modern Surveying Instruments and Techniques
2	CEDLO5012	Building Services & Repairs
3	CEDLO5013	Sustainable Building Materials
4	CEDLO5014	Advanced Structural Mechanics
5	CEDLO5015	Air and Noise Pollution & Control
6	CEDLO5016	Transportation Planning & Economics
7	CEDLO5017	Advanced Concrete Technology

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai

(With Effect from A.Y. **2021-2022**)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC601	Design & Drawing of Steel Structures	03	-	-	03	-	-	03
CEC602	Water Resources Engineering	03	-	-	03	-	-	03
CEC603	Geotechnical Engineering-II	03	-	-	03	-	-	03
CEC604	Environmental Engineering	04	-	-	04	-	-	04
CEDLO601X	Department Level Optional Course -2	03	-	-	03	-	-	03
CEL601	Design & Drawing of Steel Structures	-	02	-	-	01	-	01
CEL602	Water Resources Engineering	-	02	-	-	01	-	01
CEL603	Geotechnical Engineering-II	-	02	-	-	01	-	01
CEL604	Environmental Engineering	-	02	-	-	01	-	01
CEL605	Skill Based Lab Course – III	-	03	-	-	1.5	-	1.5
CEM601	Mini Project – 2B	-	03$	-	-	1.5	-	1.5
Total		**16**	**14**	**-**	**16**	**07**	**-**	**23**

Examination Scheme										
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test – I	Test - II	Avg.					
CEC601	Design & Drawing of Steel Structures	20	20	20	80	04	-	-	100
CEC602	Water Resources Engineering	20	20	20	80	03	-	-	100
CEC603	Geotechnical Engineering-II	20	20	20	80	03	-	-	100
CEC604	Environmental Engineering	20	20	20	80	03	-	-	100
CEDLO601X	Department Level Optional Course -2	20	20	20	80	03	-	-	100
CEL601	Design & Drawing of Steel Structures	-	-	-	-	-	25	25	50
CEL602	Water Resources Engineering	-	-	-	-	-	25	25	50
CEL603	Geotechnical Engineering-II	-	-	-	-	-	25	25	50
CEL604	Environmental Engineering	-	-	-	-	-	25	25	50
CEL605	Skill Based Lab Course-III	-	-	-	-	-	25	25	50
CEM601	Mini Project – 2B	-	-	-	-	-	25	25	50
Total		**100**			**400**	**-**	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. **2021-2022**)

Semester - VI

Department Level Optional Course – 2

Sr. No.	Course Code CEDLO601X	Department Level Optional Course – 2
1	CEDLO6011	Rock Mechanics
2	CEDLO6012	Biological Processes & Contaminant Removal
3	CEDLO6013	Construction Equipment & Techniques
4	CEDLO6014	Urban Infrastructure Planning
5	CEDLO6015	Open Channel Flow
6	CEDLO6016	Computational Structural Analysis
7	CEDLO6017	Traffic Engineering and Management
8	CEDLO6018	Introduction to Offshore Engineering

Program Structure for Third Year Engineering
Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC701	Design & Drawing of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC702	Quantity Survey, Estimation and Valuation	03	-	-	03	-	-	03
CEDLO701X	Department Level Optional Course – 3	03	-	-	03	-	-	03
CEDLO702X	Department Level Optional Course – 4	03	-	-	03	-	-	03
CEILO701X	Institute Level Optional Course – 1	03	-	-	03	-	-	03
CEL701	Design & Drawing of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL702	Quantity Survey, Estimation and Valuation	-	02	-	-	01	-	01
CEP701	Major Project – I	-	$06^{\$}$	-	-	03	-	03
Total		**15**	**10**	-	**15**	**05**	-	**20**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701X	Institute Level Optional Course – 1	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project – I	-	-	-	-	-	50	-	50
Total		**100**			**400**	-	**100**	**50**	**650**

$ indicates work load of Learner (Not Faculty), for Major Project.

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. **2022-2023**)

Semester - VII

Department Level Optional Course – 3

Sr. No.	Course Code CEDLO701X	Department Level Optional Course – 3
1	CEDLO7011	Prestressed Concrete
2	CEDLO7012	Applied Hydrology and Flood Control
3	CEDLO7013	Appraisal and Implementation of Infra Projects
4	CEDLO7014	Analysis of Offshore Structures
5	CEDLO7015	Advanced Construction Technology
6	CEDLO7016	Pavement Materials Construction and Maintenance

Department Level Optional Course – 4

Sr. No.	Course Code CEDLO702X	Department Level Optional Course – 4
1	CEDLO7021	Foundation Analysis and Design
2	CEDLO7022	Solid hazardous waste management
3	CEDLO7023	Ground Improvement techniques
4	CEDLO7024	Green building constructions
5	CEDLO7025	Legal Aspects in constructions
6	CEDLO7026	Environmental impact assessment
7	CEDLO7027	Advanced Steel Structures

Institute Level Optional Course – I

Sr. No.	Course Code CEILO701X	Institute Level Optional Course – I
1	CEILO7011	
2	CEILO7012	

3	CEILO7013	

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2022-2023)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC801	Construction Management	03	-	-	03	-	-	03
CEDLO801X	Department Level Optional Course – 5	03	-	-	03	-	-	03
CEDLO802X	Department Level Optional Course – 6	03	-	-	03	-	-	03
CEILO801X	Institute Level Optional Course – 2	03	-	-	03	-	-	03
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – II	-	12$	-	-	06	-	06
Total		**12**	**14**	**-**	**12**	**07**	**-**	**19**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC801	Construction Management	20	20	20	80	03	-	-	100
CEDLO801X	Department Level Optional Course – 5	20	20	20	80	03	-	-	100
CEDLO802X	Department Level Optional Course – 6	20	20	20	80	03	-	-	100
CEILO801X	Institute Level Optional Course – 2	20	20	20	80	03	-	-	100
CEL801	Construction Management	-	-	-	-	-	25	25	50
CEP801	Major Project – II	-	-	-	-	-	50	100	150
Total		**80**			**320**	**-**	**75**	**125**	**600**

$ indicates work load of Learner (Not Faculty), for Major Project.

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. **2022-2023**)

Semester VIII

Department Level Optional Course – 5

Sr. No.	Course Code CEDLO801X	Department Level Optional Course – 5
1	CEDLO8011	Bridge Engineering
2	CEDLO8012	Design of Hydraulics Structures
4	CEDLO8013	Construction Safety
5	CEDLO8014	Pavement Design
6	CEDLO8015	Industrial Waste Treatment
7	CEDLO8016	Soil Dynamics

Department Level Optional Course – 6

Sr. No.	Course Code CEDLO802X	Department Level Optional Course – 6
1	CEDLO8021	Repairs, Rehabilitation and Retrofitting of structures
2	CEDLO8022	Physio-Chemical Properties of Waste And Sewage Water
3	CEDLO8023	Transportation System Engineering
4	CEDLO8024	Smart Building Materials
5	CEDLO8025	Structural Dynamics
6	CEDLO8026	Ground Water Engineering

Institute Level Optional Course-2

Sr. No.	Course Code CEILO801X	Institute Level Optional Course-2

1	CEILO8011	
2	CEILO8012	
3	CEILO8013	

Faculty may design and conduct practicals for elective subjects wherever possible, under the head ‘content beyond syllabus’.

Semester V

Semester-V

Course Code	Course Name	Credits
CEC501	Theory of Reinforced Concrete Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Working Stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e., steel and concrete. The Limit State Method (LSM) is based on the statistical probability which provides the rational solution to the design problems. The philosophy which lies behind, LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The subject involves the application of working stress method and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

1 To develop clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using working stress method (WSM) and limit state method (LSM).

2 To study various clauses of IS: 456-2000 and their significance in the RCC design.

3 To apply various concepts of LSM in the analysis and design of beams, slabs and columns.

4 To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.

5 To develop the concept of design using design charts and curves for columns subjected to axial load and moment.

6 To study the concept of reinforced concrete footing design subjected to axial load and moment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Working Stress Method:**		06
	1.1	Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS:456-2000; stress- strain curve of concrete and steel, characteristics of concrete and steel reinforcement.	
	1.2	Concept of balanced, under reinforced and over reinforced sections.	
	1.3	Analysis and design of singly reinforced and doubly reinforced rectangular beams for Flexure.	
2	**Limit State Method:**		03
	2.1	Introduction to limit state method of design as per IS:456-2000.	
	2.2	Concepts of probability and reliability, characteristic load, characteristic strength, partial safety factors for loads and materials, introduction to various limit states of collapse and serviceability.	
3	**Limit State of Collapse: Flexure, Shear, Bond and Torsion:**		12
	3.1	Design of singly and doubly reinforced Rectangular and Flanged sections for flexure, shear and bond.	
	3.2	Design of beams subjected to bending, shear and torsion.	
4	**Design of Slabs using Limit state method:**		04
	4.1	Design of simply supported one-way slabs as per IS:456-2000.	
	4.2	Design of simply supported two-way slabs as per IS:456-2000.	
5	**Limit State of Collapse – Compression:**		08
	5.1	Limit state of collapse: compression for short and slender column.	
	5.2	Introduction to Members subjected to combined axial and uniaxial as well as biaxial bending.	
	5.3	Development of interactive curves and their use in column design.	
6	**Design of Foundations:**		06
	6.1	Design of Isolated square and rectangular footings subjected to axial load and moment.	
	6.2	Introduction to basic concepts of combined rectangular pad footing, slab beam type footing and Raft foundation.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the fundamentals of WSM and LSM.
2. Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
3. Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
4. Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. **Use of IS:456-2000 shall be allowed in the examination.**
2. Question paper will comprise of total six questions, each carrying 20 marks.
3. Question 1 will be compulsory and should cover maximum contents of the curriculum.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Four questions need to be solved in total.

Recommended Books:

1. Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.
2. Limit State Design of Reinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel; Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon, Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.
4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. RCC Design (WSM and LSM): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
7. Limit State Design of Reinforced Concrete (as per IS: 456-2000): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
8. Relevant IS Codes: BIS Publications, New Delhi.

Semester-V

Course Code	Course Name	Credits
CEC502	Applied Hydraulics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The knowledge of this course is essential to understand facts, concepts of impact of jets, Miscellaneous Hydraulic Machinery. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines. It also helps to study the concept of uniform Flow Through Open Channels, Non-Uniform Flow Through Open Channels.

Objectives

The students will be able to learn:

1 To introduce the concept of impact of jets.

2 To study hydraulic machines like centrifugal pumps and turbines.

3 To study various Miscellaneous Hydraulic Machinery.

4 To study the uniform flow through open channels and design of most economical section.

5 To study the non-uniform flow through open channels.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	**Impact of Jets** Impulse momentum principle, Jet striking flat plates, stationary and moving vertical, inclined plates, hinged plates, curved vanes, series of plates and vanes mounted on wheel, concept of velocity triangles.	07
2	**Hydraulic Turbines** General layout of hydro-electric plant, heads, efficiencies of turbine, classification, concept of velocity triangles working of Impulse Turbine (Pelton Wheel), Reaction Turbine, Francis Turbine, Kaplan Turbine, draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.	08
3	**Centrifugal Pumps** Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, concept of velocity triangles, specific speed, model testing, priming, characteristic curves, NPSH, cavitation.	04
4	**Miscellaneous Hydraulic Machinery** Hydraulic Ram, Press, Accumulator, Intensifier, Crane and Lift.	03
5	**Uniform Flow Through Open Channels** Uniform Flow: Flow through open channel: Definition, types of channels, Prismatic, non-prismatic channels, Types of flows in channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-sections (most economical sections).	07
6	**Non-Uniform Flow Through Open Channels** Concept of Specific energy and specific energy curve, Dimensionless specific energy discharge curve, applications of specific energy and Momentum principle to open channel flow, specific force. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles, Hydraulic jump and standing wave.	10
	Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Describe impact of jet on stationary, moving, hinged and series of plates also solve the numerical based on forces acting on it.
2. Distinguish various types of turbines, Characteristic curves and its components.
3. Analyze Centrifugal pumps by incorporating velocity triangle diagrams.
4. Know the working mechanism of various Hydraulic machines.
5. Identify the hydraulic behaviour of open channel flow and design the most economical section of channels.
6. Explain mathematical relationships for hydraulic jumps, surges, and critical, uniform, and gradually-varying flows.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only four questions need to be solved in total.

Recommended Books:

1. Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.
2. Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4. Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.
5. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.
6. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7. Flow through open channels, K.G. Ranga Raju. (1993) : New Delhi : Tata McGrawHill, c1993.
8. Flow Through Open Channels. Rajesh Srivastava (2007): Oxford University Press, 2007, pbk, 432 p, ISBN: 0195690385.

Reference Books:

1 Fluid Mechanics: Frank M. White, Tata Mc-Graw Hill International Edition.
2 Fluid Mechanics: Streeter White Bedford, Tata Mc-Graw International Edition.
3 Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Finnemore, Tata Mc-Graw Hill, New Delhi.
4 Hydraulics: James F. Cruise. Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
5 Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.
6 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York.
7 Open Channel Flow: Henderson F.M., McGraw Hill International, New York.

Semester-V

Course Code	Course Name	Credits
CEC503	Geotechnical Engineering-I	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Around all civil engineering structures are supported by soil and rock. Rock is rarely occurring and hence, mostly the supporting medium is soil. The stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basic understanding of physical properties of soil which are useful for determining the strength, compressibility, drainage characteristics etc. Soil mechanics is the basic tool for geotechnical engineering, which is the specialized section of civil engineering. Soil is also used as a construction material to build various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I.

Objectives

1 To study origin and mode of formation of soil as well as functional relationships among different unit weights, volumetric ratios, and water content.

2 To study clay mineralogy and plasticity characteristics of soils.

3 To comprehend particle size distribution and classification of soils as per IS code.

4 To study permeability and seepage flow of water through the soil.

5 To understand the concept of total stress, neutral stress and effective stress in soil.

6 To understand compaction characteristics of soils as well as the techniques of soil exploration, assessing the subsoil conditions and engineering properties of various soil strata.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Geotechnical Engineering, Basic Definitions & Relationships**		07
	1.1	Definitions and scope of Geotechnical Engineering: rocks, soil, origin & mode of formation and types of soil obtained, soil mechanics, rock mechanics, geotechnical engineering.	
	1.2	Soil phase systems, volumetric ratios: void ratio, porosity, degree of saturation, air voids, air content.	
	1.3	Weight-volume relationship: different unit weights, water content, specific gravity of soil solids, mass and absolute specific gravity.	
	1.4	Functional relationships among different unit weights, volumetric ratios, and water content.	
	1.5	Relative density, relative compaction.	
	1.6	Different methods to determine water content, specific gravity and unit weight of soil.	
2	**Clay Mineralogy and Plasticity Characteristics of Soils**		06
	2.1	Explanation about clay minerals, e.g., Montmorillonite, Illite and Kaolinite; formation of clay minerals and their role in plastic behavior of soil.	
	2.2	Definition of plasticity of soil, consistency of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.3	Definitions of shrinkage parameters, plasticity index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soil. Importance of consistency limits.	
3	**Particle Size Distribution and Classification of Soils**		06
	3.1	Wet & dry sieve analysis, Sedimentation analysis: Stoke's law, Hydrometer method of analysis, Limitation of sedimentation analysis.	
	3.2	Particle size distribution curve/ gradation curve and its uses. Introduction to cohesive and cohesionless soil.	
	3.3	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498 -1970, boundary classification.	
4	**Permeability of Soils & Seepage Analysis**		08
	4.1	Types of soil water, definition of hydraulic head, hydraulic gradient, Darcy's law, validity of Darcy's law, permeability of soil.	
	4.2	Determination of coefficient of permeability of soil in lab using constant head and variable head methods, factors affecting permeability of soil, effect of permeability on various properties of soil, determination of in-situ permeability with pumping out and pumping in tests.	

	4.3	Permeability of stratified soil deposits.	
	4.4	Definition of seepage and its importance for the analysis & design of hydraulic structures, graphical representation of seepage by flow net diagram, definition of flow line, equipotential line, flow channel, flow field, characteristics of flow net, use of flow net, phreatic line.	
	4.5	Factor of safety against piping failure.	
5	**Effective Stress Principle**		**05**
	5.1	Definition of geostatic stresses, total stress, neutral stress/ pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage pressure on effective stress; quick sand condition.	
6	**Compaction of Soil & Soil Exploration**		**07**
	6.1	Theory of compaction, determination of optimum moisture content (OMC) & maximum dry density (MDD) in laboratory by conducting the light and heavy compaction tests.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, soil structure, placement water content, relative compaction, Proctor needle method for compaction.	
	6.3	Necessity of soil exploration, methods of soil investigation, methods of boring, disturbed and undisturbed soil samples, soil sampling and samplers, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometer tests: SPT, SCPT and DCPT.	
	6.5	Representation of data with borehole logs.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the basic concepts of the physical and engineering properties of soil and derive the relationships among various unit weights & other parameters.

2 Comprehend clay mineralogy and plasticity behavior of clay.

3 Analyze grain size distribution of soil and classify the soil as per IS code.

4 Evaluate the coefficient of permeability of different types of soils and draw the flow net diagram to estimate seepage discharge.

5 Compute the effective stress and pore water pressure inside the soil mass under different geotechnical conditions.

6 Evaluate the compaction parameters in laboratory and field as well as understand the necessity and methods of soil exploration.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.

Recommended Books:

1 Basic and Applied Soil Mechanics: Gopal Ranjan, A S R Rao; New Age International Publishers.
2 Soil Mechanics and Foundation Engineering: V. N. S. Murthy; CBS Publishers & Distributors
3 Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors, New Delhi.
4 Soil Mechanics and Foundations: B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications (P) LTD., New Delhi
5 Geotechnical Engineering: C. Venkatramaiah; New Age International Private Limited
6 Fundamentals of Soil Engineering: D. W. Taylor; John Wiley & Sons.

Reference Books:

1 An Introduction to Geotechnical Engineering: Robert D. Holtz, William D. Kovacs; Prentice-Hall, New Jersey
2 Soil Mechanics: R. F. Craig; Spon Press, Taylor and Fransis Group
3 Soil Mechanics: T. W. Lambe, R. V. Whitman; John Wiley & Sons
4 Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi
5 Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B Peck, Gholamreza Mesri; John Wiley & Sons

Semester-V

Course Code	Course Name	Credits
CEC504	Transportation Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

An efficient transportation system is essential for sustainable economic development of the country and plays a significant role in promoting national and global integration. An efficient Transportation system helps in increasing productivity and enhances competitiveness of the economy. Hence, the transport sector is considered as an important component of the economy and a common tool used for development. Three basic modes of transportation include land, water and air. The course deals with understanding of basics of different modes of transportation (Highways, railways, airways and waterways). The highways owing to its flexibility in catering door-to- door service is one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways in addition to traffic planning, operation and control.

Objectives

1 To understand the technical aspects of Railways, Airways and Waterways.

2 To carry out Planning and design of geometric elements of Highways.

3 To study various traffic studies and to understand elements of Traffic Engineering for efficient planning and control.

4 To study Requirements of Highway materials and to design Rigid and flexible pavements using IRC codes.

5 To study methods of construction of Rigid and Flexible pavements, use of soil stabilization and drainage to highways.

6 To design the overlay on basis of pavement evaluation and failure identification on rigid and flexible pavements.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Transportation Systems**		10
	1.1	Introduction to Transportation Engineering, Comparison of various modes of transportation (Roadways, Railways, Airways and Waterways).	
	1.2	Introduction to Railway Engineering: Cross sectional elements of railway track (Foundation, Ballast, Sleepers and Rail), Introduction to turnout, Super elevation design, Negative Super elevation, Construction and Maintenance of Railway track.	
	1.3	Introduction to Airport Engineering: Elements of Airport, Site selection of Airport, Design of Runway length, Taxiway and Exit Taxiway design.	
	1.4	Introduction to Waterways: Definition of Docks, Harbor and Ports. Elements and types of Docks, Harbor and Port.	
2	**Planning and Geometric Design of Highways**		10
	2.1	Classification of roads based on various criteria, Road development plans, agencies related to highway development, Highway alignment (basic requirement and factors governing), hill roads, Surveys for highway location.	
	2.2	Terrain Classification, Vehicular Characteristics, Cross section elements of highways (width of carriage way, shoulders, medians, width of road way, right of way, camber & its profile).	
	2.3	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.4	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.5	Gradients: different types, maximum, minimum, ruling exceptional, grade compensation on curves.	
3	**Traffic Engineering**		10
	3.1	Introduction to various traffic studies such as speed study, volume study, parking study, accident study, O&D study etc. Speed study: methods to determine speed, types of speed (Spot speed, Design speed, Upper & lower limit speeds, Mean - Median and Modal speed); Traffic Volume study (flow): Definition, AADT, ADT, Design volume, methods of determining traffic volume. Traffic density: Definition, importance.	
	3.2	Introduction to Relationship between Speed, density and volume. Capacity: Q-K-V curve, Different types and factors affecting capacity, Concept of PCU and LOS.	
	3.3	Introduction to traffic control devices Traffic signs, signals (no design), road marking.	

	3.4	Different types of Intersections-At-grade and Grade Separated; Grade separated interchanges; rotary intersection.	
4	**Pavement Material and Design**		**12**
	4.1	Types of pavements, comparison of flexible and rigid pavements, Requirements of pavement materials, Soil: requirement of soils as subgrade material, CBR test. Aggregate: Requirements of aggregate as Pavement material, Tests on aggregate with specified values. Bitumen: Requirements of bitumen as pavement material test on bitumen with specified values, variants of bitumen (Modified bitumen) and its uses. Introduction to Bituminous mix design using Marshall Stability test.	
	4.2	Flexible pavement design: Concepts related to flexible pavement design such as tyre pressure, contact pressure, ESWL, VDF and LDF. IRC approach for design (IRC: 37-2001, IRC: 37-2012), also IRC SP 72-2007/2015 and IRC 77 2008.	
	4.3	Rigid pavement design: Modulus of subgrade reaction, equivalent radius of resisting section, radius of relative stiffness, stresses on rigid pavement, combine loading temperature stress.; Design of rigid pavements (IRC: 58-2002; IRC: 58-2011, IRC: 58-2015. IRC: SP-62-2004, IRC: SP-62-2014)	
5	**Pavement Construction, Soil Stabilization and Drainage**		**05**
	5.1	Construction of different types of roads: water bound macadam (WBM) road, WMM, bituminous pavements, cement concrete pavement. And joint (As per IRC, MORTH specifications) jointed reinforced, continuously reinforced; fiber reinforced; roller compacted concrete pavements.	
	5.2	Soil Stabilization: Significance, Principle of soil stabilization, different methods of soil Stabilization, use of Geosynthetics in highways and allied structures.	
	5.3	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage-surface and subsurface drainage inkling for the roads in hilly areas.	
6	**Pavement Evaluation, Failures and Maintenance**		**05**
	6.1	Evaluation of pavement, Structural and functional evaluation, methods of structural evaluation (working of Benkelman beam, FWD, LWD), methods of functional evaluation (working of Bump indicator, profilometric systems)	
	6.2	Distress / failure in Rigid and flexible pavement, reasons and measures.	
	6.3	Strengthening of existing pavement, Overlay and its types, design of overlay (Benkelman beam method)	
		Total	**52**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Compare various modes of transportation and understand basic technical aspects of railways, airways and waterways.
2 Understand different road plans, requirements of alignments and Design horizontal and vertical geometrical elements of highways.
3 Carry out different traffic studies and analyze basic parameters of traffic engineering for efficient planning and control of traffic.
4 Design the flexible and rigid pavement as per relevant IRC codes.
5 Construct different types of pavements, use of soil stabilization and planning of highway drainage.
6 Carry out structural and functional evaluation of pavement, identify the failures and design the overlay.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.

Recommended Books:

1 A Course of Railway Engineering: Saxena, S. C. and Arora, S. P.; Dhanpat Rai Sons, New Delhi.
2 Airport Planning Design: Khanna, S.K., Arora, M.G.and Jain, J.J.;Nemchand Bros., Roorkee. .
3 Docks and Harbour Engineering: Bindra, S. P.; Dhanpat Rai and Sons,New Delhi.
4 Highway Engineering: Khanna, S.K. and Justo, C. E. G.; Nem Chand and Bros., Roorkee.
5 Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
6 Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.

Reference Books:

1. Indian Railway Track: Agarwal, M. M., Suchdeva Press New Delhi.
2. Planning Design of Airport: Horonjeff Mckelrey, Tata Mc-Graw Hill India Publishing House, New Delhi.
3. Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House.
4. Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi.
5. Principles of Transportation Engineering: Chakrabory, Partha and Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi.
6. Transportation Engineering: Khisty, C.J. and Lall, Kent, B.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
7. Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi.
8. Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publsihers, Delhi.
9. Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEDLO5011	Department Level Optional Course - 1 Modern Surveying Instruments and Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Revolutionary changes have taken place in the last few years in surveying instruments and techniques that are used for measuring level differences, distances, angles, areas, volumes, etc. This has become possible due to the advent of electronics in the surveying instruments. With rapid advancements in the technology and availability of cheaper and innovative electronic components, these instruments have become affordable and user friendly.

This course outlines the advancements in instruments and techniques such as digital levels, electronic distance measuring instruments, electronic theodolites, total stations, GPS, GIS, Remote Sensing, drone survey, aerial photogrammetry and hydrographic survey. It also makes the learner industry-ready with respect to the applications of the modern tools in data capturing and further in mapping using appropriate software.

Objectives

1 Understand the working principles and methodologies of modern surveying instruments and compare with conventional instruments.

2 Exhibit the concepts of Global Positioning System, Geographical Information system and remote sensing techniques.

3 Demonstrate the importance of Aerial photogrammetry in surveying works,

4 Develop recent methods of maintaining land records,

5 Study the art of delineating the levels underwater bodies.

6 Highlight the modern techniques in the field of surveying and mapping using various softwares.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Modern Surveying Instruments:**		06
	1.1	Principles governing modern instruments and comparison with the conventional instruments.	
	1.2	E.D.M. Electromagnetic spectrum, Electromagnetic distance measurement, Instruments – Digital planimeter, Auto Level, Laser Level, Electronic Digital Theodolite, Total Station, Scan station, Smart Station (Total station with GPS).	
2	**Geoinformatics**		12
	2.1	Global Positioning System- Global Positioning System – working principle and methods, Different Approaches to use GPS and their accuracies, Advantages of GPS in Navigation, Survey, Planning and Mapping.	
	2.2	Geographical Information System -Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management, query & analysis and visualization) of GIS. Coordinate systems and projections, Geo-referencing, GIS data – spatial (Raster & vector) & spatial data. Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of a spatial data.	
	2.3	Remote Sensing introduction, Definition, Necessity, Importance and use; Basic concepts in Remote Sensing, Basic Laws of electromagnetic radiation, Atmospheric effects on radiation, Interaction of EM energy with matter, Resolution in remote sensing, Satellite remote sensing, Problems confronting remote sensing system. Ideal and Real remote sensing systems.	
3	**Aerial Photogrammetry**		06
	3.1	Introduction, principle and uses of Aerial photographs, Definitions, of different terms, Scale of vertical and tilted photograph (simple problems), Ground Coordinates.	
	3.2	Relief Displacements, Ground control, Procedure of aerial survey, overlaps and mosaics, Stereoscopes	
4	**Cadastral Surveying**		04
	4.1	Cadastral Surveying: Contemporary Techniques of maintaining survey records, 7-12 Extracts, Form-8 (Namuna-8).	
	4.2	Role of Survey Department, Role of revenue department. Soft/digitized formats of land records, Comparison with conventional record keeping	
5	**Hydrographic Surveying**		04
	5.1	Hydrographic Surveying: Objects, Applications, establishing controls, Shore line survey, Sounding, sounding equipment, Methods of locating soundings – conventional and using GPS.	

	5.2	Reduction of soundings, Plotting of soundings, Nautical sextant and its use, Tides and tide gauges, determination of MSL.	
6	**Applications of Modern Survey Techniques and Map Preparation Using Software**		07
	6.1	Applications of Total Station, GIS, GPS, Remote sensing, LIDAR, Drones in Civil Engineering.	
	6.2	Introduction of GRAM++, Q-GIS, Map Info etc.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Compare modern surveying instruments with conventional instruments.

2 Elucidate the utility of geoinformatics in surveying data collection and analysis.

3 Explain the utility of Aerial photogrammetry in surveying works.

4 Highlight the improvement in land record keeping and governance using modern tools.

5 Describe the procedure of hydrographic surveying and mapping.

6 Apply modern surveying tools to solve complex problems and demonstrate essential skills for working on surveying software.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only four questions need to be solved in total.

Recommended Books:

1. Agor R, Advanced Surveying, Khanna Publishers, New Delhi (ISBN9788174909053).
2. Kanetkar, T.P. and Kulkarni, S.V., Surveying and Levelling Vol. II, Pune Vidhyarthi Gruh Publication (ISBN9782508807185).
3. Arora, K.R., Surveying Vol. III, Standard Book House. New Delhi (ISBN9788189401276).
4. Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648
5. B. C. Punmia, Ashok K Jain, Arun K Jain, Advance Surveying, Laxmi Publications (ISBN 9788170088530)
6. R. Subramanian, Surveying and levelling, Oxford University Press, New Delhi (ISBN9780198085423)
7. P.Dong , Q.Chen, Lidar Remote Sensing and applications ,CRC Press (ISBN 9781138747241)

Reference Books:

1. Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648
2. T.M Lillesand, R.W Kiefer, and J.W Chipman, Remote sensing and Image interpretation, 5th edition, John Wiley and Sons, India; ISBN: 978-1-118-34328-9
3. Kaplan E.D and Hegarty C.J., Understanding GPS: principles and applications, Artech House (ISBN978-1-63081-058-0)
4. Wolf P.R. and Dewitt B.A., Elements of Photogrammetry, McGraw Hill,(ISBN 978-0072924541)
5. DeMers M.N., Fundamentals of GIS, John Wiley (ISBN978-0470129067)
6. Gibson P.J., Introductory Remote Sensing: Principles and Concepts, Routledge (ISBN0 415 18962 4).

Semester-V

Course Code	Course Name	Credits
CEDLO5012	Department Level Optional Course - 1 Building Services and Repairs	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The building services are based on engineering operations of buildings & the built environment. Building services are responsible for the environment in which we live & work. Building service systems are complex. They are typically a major source of cost & potential problems in building service conditions. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professionals. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in buildings. For an existing building, it is necessary to be in a good condition to perform the intended functions. Adequate maintenance extends the building life & ensures the safety of occupants. Most of the structures are getting old & are in the dire need of the repair and maintenance. Hence, there is a huge employment potential in conformity with the field of repair and maintenance. This course, therefore, finds its place in the curriculum such that the pupils can acquire the competency in this area. The course deals with the different building services, health monitoring of buildings, their maintenance, repair materials and repair methodologies.

Objectives

1. To understand the concepts of mechanical systems in buildings such as lifts, escalators, HVAC systems, pumps & their applications.
2. To understand design concepts of electrical system, safety and illumination fundamentals.

3 To get familiar with the plumbing system and services in buildings related to water supply, drainage, gas supply and firefighting installations.

4 To learn about causes of distress of concrete structures and learn various instrumental testing methods for Condition assessment & evaluation of structure and assess the extent of repairs.

5 To acquire the knowledge of repair materials and repair methodologies for rehabilitation of RCC structures.

6 To learn implementing repair process and to follow safety during construction work.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Building services: Mechanical systems.**		06
	1.1	Lifts/elevators, escalators, conveyors: their components, capacity and principles of working, common problems.(3L)	
	1.2	Motors, Generators, Pumps, HVAC Systems - Heating systems, Cooling Systems, Packaged HVAC, types, capacity, components and their principles of working, common problems.(3L)	
2	**Building services: Electrical systems & Illumination in Buildings**		07
	2.1	Electrical grids and supply system: Layout of substations Transformers & switch gears, Main & distribution boards, electrical systems in buildings, Single / Three phase supply, ISI specifications, electrical load, electrical layout plan in a building, Types of wires, wiring system & their choice, Solar energy, CCTV, LAN. Protective devices in electrical installation: Earthing for safety, Types of Earthing, fuses, circuit breakers, lightening arrester.(4L)	
	2.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Luminous flux, candela, solid angle illumination, utilization factor. Modern theory of light &color: Synthesis of Light, Additive & Subtractive synthesis of colour, classification of lighting, artificial lights sources, spectral energy distribution, luminous efficiency, color temperature, colour rendering. Level of illumination: Lighting for stores, offices, school, hospitals and house lighting, elementary idea of special features required and minimum level of illumination required in buildings.(3L)	
3	**Building services: Plumbing Systems in Building**		06
	3.1	Water Distribution system: Material for service pipes, service connection, size of service pipe, Water meter, valves and storage tanks, water requirement for domestic use and firefighting.(2L)	

	3.2	Drainage system: Pipe and traps, system of plumbing, house drainage plans, Chambers- gradient and spacing, manholes, septic tanks and soak pit, Introduction to rain water harvesting system.(2L)	
	3.3	Other plumbing systems: Fire safety, fire-fighting installations, types and purpose, piped gas supply systems, AC ducting.(2L)	
4	**Deterioration of Concrete Structures & Condition assessment**		06
	4.1	Durability & Causes of deterioration of concrete structures: effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design errors & construction errors, causes of seepage & leakage in concrete structures, formation of cracks including those due to corrosion.(2L)	
	4.2	Condition Survey, Evaluation & Damage Assessment: Structural audit and bye laws. Diagnostic methods & analysis. Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity test, and crack measurement techniques, Concrete endoscopy & thermal imaging, pull- off test & pull-out test.(4L)	
5	**Repair Materials & Methodologies For Repairs**		08
	5.1	Repair analysis, Repair materials: and their desired properties, Polymer modified mortar/ concrete, micro concrete, bonding chemicals, protective materials and their properties for moisture barrier systems, water-proofing of concrete structures, Systems like integral, crystalline, coatings, membranes, joints sealants, crack repair fillers, corrosion resistant steels, Pre-packed zinc sacrificial anode, Snap-On zinc mesh anode CP system, corrosion inhibitors, rust solvents.(4L)	
	5.2	Repair methodologies: Crack and patch repair, Injection grouting, surface coatings, column jacketing, guniting, shotcrete, Ferroconcrete, FRP, Carbon fiber wrapping, methods of rebar corrosion protection, cathodic protection.(4L)	
6	**Repair Process Implementation and Safety During Repairs**		06
	6.1	Legal Documentation and Records: Estimates of repair work, procedure and flow chart for repairs, Bill of quantities, Tendering, Work order, Agreement and Contract, Measurement book, bills, security deposits, role of PMC.(3L)	
	6.2	Safety during Repairs: Causes of accidents, safety signs, barricading, insurance, Temporary Support structures such as, formwork, shuttering, centering, staging and scaffolding.(3L)	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Apply the knowledge of working & installation of mechanical utility services in buildings.
2 Understand the electrical supply lines, materials, safety devices and illumination systems used in buildings.
3 Investigate and learn operations and adopt appropriate materials in plumbing systems & integrate the same into the building projects.
4 Assess the structural health of the buildings & adopt repair strategy to the damaged structures.
5 Implement the right methods and materials for repairing the concrete structures and also decide the sequence of operations.
6 Create and understand proper documentation process and adopt practices for safety for protection of men and materials on the repair site.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.

Recommended Books:

1 Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968
2 Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
3 Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4 The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
5 National Building Code.
6 Building Construction: *Dr. B. C. Punmia, Ashok K Jain*, A.K Jain
7 Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
8 Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi

9 Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication

10 Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.

Building Services and Repairs: Dr. A. S. Radke, Tech Knowledge Publications

Reference Books:

1 Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia

2 CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf.

3 Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.

4 Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis publication

5 Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.

6 Testing of Concrete in Structures: *John H. Bungey, Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.

7 Durability of concrete and Cement Composites: *Page, C.L.* and Page, *M.M.,* Woodhead Publishers

8 Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi

9 MEP systems & Repairs of Buildings: A.S. Radke, Published by Synergy Knowledgeware.

Semester-V

Course Code	Course Name	Credits
CEDLO5013	Department Level Optional Course - I Sustainable Building Materials	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Meeting the needs of the present without compromising the ability of future generations to meet their needs is considered to be the simplest and effective sustainable development. The greatest threats to the sustainable development on earth are: population growth and urbanization, energy use and global warming, excessive waste generation and the subsequent pollution and limited supply of resources. Concrete is the primary construction material in the world. Construction industry consumes 40 percent of the total energy and about one half of world's major resources. Hence, it is imperative to regulate the use of materials and energy in this industry. The largest environmental impact of the concrete industry comes from the cement manufacturing process that leads to relatively high greenhouse gas emissions. Minimizing the quantity of cement in a concrete mix has many potential benefits. Thus, the use of industrial byproducts such as fly ash, silica fume as cementitious materials in concrete structures can lead to significant reduction CO2 emissions and consumption of energy and raw materials. Green and intelligent buildings also have been evolved for sustainability of the construction industry. This course provides knowledge of different sustainable building materials and technologies in construction industry.

Objectives

1 To have more awareness among students about sustainability.

2 To understand environmental issues due to building materials and the energy consumption in manufacturing building materials.

3 To study the alternative masonry unit and mortar for sustainable practices.

4 To know the importance of cement reduction and replacements for a sustainable development.

5 To understand the alternative building technologies which are followed in construction.

6 To have cognizance of alternative roofing systems in practice.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Sustainability**		07
	1.1	Introduction: Need and concept of sustainability, Social Environmental and economic sustainability concepts,	
	1.2	Sustainable development, Nexus between technology and Development, Challenges for sustainable development Fundamentals of sustainability.	
	1.3	Global Environmental issue: Resource degradation, ozone layer Depletion Climate change, Carbon cycle, Factors affecting Carbon credits and carbon trading, carbon foot Print, Carbon sequestration-carbon capture and storage (CCS).	
	1.4	Environment legislation in India-water act and air act	
2	**Energy In Building Materials**		06
	2.1	Embodied energy and life cycle energy, Calculation of embodied energy in wall, Environmental issues concerned to building materials, Global warming and construction industry.	
	2.2	Environment friendly and cost-effective building technologies. Requirements for building of different climatic regions.	
	2.3	Traditional building methods and vernacular architecture Green buildings, Intelligent buildings, green materials, green building ratings-IGBC & LEED.	
	2.4	Renewable and nonrenewable energy sources.	
3	**Elements of Structural Masonry**		06
	3.1	Characteristics of building blocks for walls, Stones and Laterite blocks, Bricks, Fly ash bricks and hollow clay blocks, Concrete Blocks, Stabilized blocks: mud blocks, steam cured blocks, Fal-G Blocks stone masonry block.	
	3.2	Masonry Mortars: Mortars, Cementitious materials: Lime, OPC, PPC, Masonry cement, Lime pozzolana (LP)cement. Sand: natural and manufactured, Classification of mortar as per BIS, Types of mortar, Properties and requirements of mortar, Selection of mortar.	
4	**Cementitious and Supplementary Cementitious Materials and their Characterization:**		06
	4.1	Lime, Lime pozzolana cements, Pozzolana: Surkhi, Fly ash, IS (3812) (Type C and F), GGBFS, Silica Fumes, Metakaolin,	

		RHA, Composite cements and its types, IS (16415:2015), Magnesia based cements, Calcium sulfo- cement, Alkali activated, cement (Type 1 and Type II), Geopolymers. Composition, Properties and uses.	
	4.2	Membrane curing: wax and resin based, self-curing compound: Polymer and polyethylene glycol, Water reducing admixtures, use of treated domestic effluent (TDE) for mixing and curing	
5	**Alternate Building Technologies**		**07**
	5.1	Fiber reinforced cement composites: Matrix materials, reinforcing Materials, Applications	
	5.2	Fiber reinforced polymer composites: Matrix materials, types of polymers used and applications	
	5.3	Ferrocement and ferroconcrete building components: Materials, Construction methods, Mechanical properties, Applications.	
	5.4	Nanotechnology for sustainable construction.	
6	**Alternate Building Materials and Roofing Systems**		**07**
	6.1	Building materials from agro and industrial waste: Typical agro- waste and biomass resources, Use of industrial waste: Fly ash, Blast furnace slag, Iron ore tailings, Gold mine tailings Granite and marble polishing fines, demolished building waste	
	6.2	Concepts in roofing alternatives, Types of roof, Roof as a structural system, Cost reduction through construction process efficiency	
	6.3	Filler slab roofs, Composite beam and panel roofs, construction Details and roof assembly.	
	6.4	Masonry domes and vaults: Relevance, analysis and design, Barrel vault.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain sustainable practices by utilizing engineering practices.

2 Able to understand different types of environmental problems and their sustainable solution.

3 Suggest appropriate type of masonry unit and mortar for civil engineering constructions.

4 Analyze different alternative building materials for construction.

5 To suggest suitable alternative building technologies for sustainable development.

6 To propose different roofing systems and use of waste materials in construction industry.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.

Recommended Books:

1 Alternative Building Materials and Technologies by KS Jagadish, BV Venkatraman Reddy and KS Nanjunda Rao, New Age International publications.
2 Sustainability Engineering: Concepts, Design and Case studies by Allen D.T, and Shonnard D.R , Prentice Hall.
3 Sustainability Engineering: Concepts, Design and Case studies by Bradley A.S; Adebayo A.O, and Mario P., Cengage learning
4 Sustainability of construction materials by Jamal M Khatib, Woodhead publishing limited.
5 Renewable energy sources by Twidell J.W and Weir A.D, English Language Book Society (ELBS)

Reference Books:

1 ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy efficiency Publications—Rating system, TERI Publications – GRIHA Rating system.
2 Structural Masonry by Arnold W Hendry, Macmillan Publishers
3 Systems Analysis for Sustainable Engineering: Theory and Application by Ni bin Chang, Mc Graw Hill Professional
4 NPTEL course on sustainable materials and green building https://nptel.ac.in/courses/105/102/105102195
5 Relevant codes

Semester-V

Course Code	Course Name	Credits
CEDLO5014	Department Level Optional Course - 1 Advanced Structural Mechanics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, torsion etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

1 To understand the concept of unsymmetrical bending, shear centre and spring & evaluate the stress due to unsymmetrical bending, shear centre for symmetrical & un- symmetrical thin-walled sections.

2 To study the concepts and behavior of beams curved in elevation & to evaluate the stress.

3 To study the concepts and behavior of beams curved in plan subjected to different types of loadings.

4 To understand the concept &behavior of beams resting on elastic foundation.

5 To understand the concept of different theories of failure in regards of materials.

6 To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Unsymmetrical Bending, Shear Centre and Springs**		**07**
	1.1	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	1.2	Shear Centre for symmetrical & unsymmetrical (about both axes) thin-walled open sections.	
	1.3	Helical springs, flat spiral springs, laminated springs.	
2	**Beams Curved in Elevation**		**07**
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	**Beams Curved In Plan**		**05**
	3.1	Analysis of Beams Curved in Plan such as cantilever circular arc, semicircular beams fixed at two ends and subjected to central concentrated load.	
	3.2	Simply supported semicircular beam subjected to UDL supported on three equally spaced columns, Analysis of circular ring beam.	
4	**Beams on Elastic Foundation**		**07**
	4.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	4.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
5	**Theories of Failure**		**07**
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	**Analysis of Deep Beams**		**06**
	6.1	Determination of deflection.	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the concept of unsymmetrical bending, shear centre for thin-walled open sections and springs.
2. Analyze hooks, circular closed rings, chain links with straight length & semi-circular ends using the concept of beam curved in elevation.
3. Analyze the beam curved in plan for different support conditions.
4. Study the behavior of beam resting on elastic foundation with various loading conditions.
5. Understand the concept of different theories of failure in different sections.
6. Determine deflection of deep beams, shear correction factor for different sections like solid & hollow sections.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only four questions need to be solved in total.

Recommended Books:

1. Mechanics of Materials: Popov, E.P. Prentice Hall of India Pvt. Ltd.
2. Advanced Mechanics of Materials: Arthur P. Boresi and Omar M. Sidebottom, Wiley and Sons.
3. Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
4. Mechanics of Solids: Shames, I and Pitarresi, J. M., Preentice Hall, New Delhi.
5. Strength of Materials: Subramanian, Oxford University Press.
6. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill,20
7. Strength of Materials: R. K. Rajput, S. Chand and Co. Ltd.

Reference Books:

1. Mechanics of Materials: Beer, F.P., E. Russell Jhonston and John T. DeWolf, TMH, New Delhi.
2. Beams on Elastic Foundation: Heteny M.
3. Mechanics of Materials: James Gere, M., Thomson Brooks.
4. Reinforced Concrete Deep Beams: F.K. KONG, Taylor & Francis Books, Inc.

Semester-V

Course Code	Course Name	Credits
CEDLO5015	Department Level Optional Course - 1 Air and Noise Pollution and Control	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air. These particles and gases can come from car and truck exhaust, factories, dust, pollen, mold spores, volcanoes and wildfires, possibly causing diseases, death to humans, damage to living organisms. Noise pollution impacts millions of people on a daily basis. The most common health problem it causes is Noise Induced Hearing Loss (NIHL). Exposure to loud noise can also cause high blood pressure, heart disease, sleep disturbances, and stress. This subject is intended to make students aware about the noise and air pollution, various sources which contribute in degradation of air quality, assessing the air quality through air quality index, and various air and noise pollution control methods and equipment used by industries.

Objectives

The students will be able to learn:

1 Understanding of basic concepts of air and noise pollution.

2 Study of air pollution episodes. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.

3 Study of sampling types and methods for ambient air and stack.

4 Study of macro and micro meteorology for understanding the dispersion of pollutants.

5 Simple and complex modeling for point source, line source and area source.

6 Study of pollution control methods, mechanism and devices, laws.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	Introduction to Air Pollution: Definition, Air pollutants and its classification and sources of generation. Emission Inventory. Indoor air pollution. Measurement of air pollution. Air pollution in India and other countries. Air Quality Index. Numerical on conversion of units of pollutants.	05
2	Environmental Effects of Air Pollution: Effects of air pollutants on human beings, plants, animals, properties and visibility. Exposure to air pollution. Numerical problems based on COH, CoHb	06
3	Measurement and Control technology of Air Pollutants: methods to measure ambient air pollution and stack emissions, high volume sampler, wind rose diagram. Control Technology: Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	10
4	Meteorological process and air quality monitoring: Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects. Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source.	10
5	Current Issues on Air Pollution and Global -Legal Aspects, air pollution laws, Indian standards- emission and air quality standards Greenhouse effect/ Global warming, Ozone Pollution, Acid Rain.	04
6	Noise Pollution: definition and introduction, the effects of noise, characteristics of sound and its measurement, levels of noise and problems, noise rating system, noise level standards, sources of noise and their noise levels, noise abatement and control.	04
	Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Identify air and noise pollution problems and interpret criteria for air and noise quality data.
2 Recognize various environmental transformation processes of pollutants under extreme weather condition.
3 Interpret meteorological data and develop capability to assessment of project proposal.
4 Knowledge to analyze quality of air in the form of air quality index and dispersion modeling.
5 Relate and analyze the pollution regulation on its scientific basis.
6 Justify the use of pollution control equipment and their design.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests --
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.
5 There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

Recommended Books:

1 Air Pollution: Rao. M. N. and Rao, H. V. N., Tata McGraw Hill Publication, New Delhi.
2 Environmental Pollution Control Engineering: Rao C.S., New Age International Publishers.
3 Noise Pollution: Agarwal S.K., APH Publishing Corporation.
4 Noise Pollution and Control Strategy: Singal S.P., Alpha Science International LTD.
5 Sewage disposal and Air pollution engineering: Garg, S.K., Khanna pbl.

Reference Books:

1 Air Pollution: Part A- Analysis and Part B-Prevention and Control: Ledbetter, J. O., Make Dekker Inc., New York.
2 Air Pollution: Wark and Warner, Harper and Row, New York.
3 Air Pollution Vol.1: Tripathi, A. K., Ashish Publication House, New Delhi.
4 Air Pollution Handbook: Magill, P. L.et al., McGraw Hill publication.
5 Air and Noise Pollution Control: Volume 1: Wang,L.K. and Pereira, N.C., Humana
6 Textbook of Noise Pollution and its Control: Bhatia S. C., Atlantic Publishers and Distributors, New Delhi.
7 Industrial Air Pollution Handbook: Parker, A., Tata McGraw Hills Publication.
8 Air Pollution: Henry Capeskins, McGraw Hill publication.
9 Environmental Noise Pollution: Noise Mapping, Public Health, and Policy,Enda Murphy and Eoin King.
10 Air Pollution: Wark and Warner, Harper and Row, New York.
11 Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. IndianStandards relevant to Air Pollution Monitoring, Definitions, Standards.
12 Air Pollution Control Theory: Martin Crawford, McGraw Hill publication.

Semester-V

Course Code	Course Name	Credits
CEDLO5016	Department Level Optional Course - 1 Transportation Planning and Economics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The ultimate aim of Transport planning is to generate alternatives for improving Transportation system to meet future demand and selecting the best alternative after proper evaluation. The Course concentrates on Transportation system planning, Public Transportation Planning, Parking planning, and economic analysis of Transportation projects. Basic purpose of transportation planning is focusing on what's the most efficient movement for people and goods around the world. Improving access to an area not only reduces congestion, but the accessibility attracts new residents and businesses ultimately helping economic development.

Objectives

1 To understand various urban development policies in India and to learn different planning surveys.

2 To analyze and plan future traffic flow using four stage modelling.

3 To understand the implementation of land use transport model in Urban area.

4 To carry out economic analyses for different transportation infrastructure projects.

5 To understand and plan Urban public Transportation system.

6 To plan and design Parking system for residential, commercial and other projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Urban Transportation Planning**		04
	1.1	Problems & factors in Transportation Planning, Development of Transportation Systems in India, Growth of Transport - Trends in Traffic - Imbalances in Transport System.	
	1.2	Urban growth mechanism – Urban morphology - Urbanization & travel demand - Urban development planning policy – NUTP - Urban transport projects - Urban transport problems in India	
	1.3	Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system, Trip based and activity-based approach - Four stage travel demand modelling.	
2	**Four Stage Modelling**		10
	2.1	Trip generation analysis: trip classification, multiple regression analysis, category analysis	
	2.2	Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model, opportunities model.	
	2.3	Modal split analysis: introduction, Modal split analysis modal split models.	
	2.4	Traffic Assignment: purpose of traffic assignment, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion Curves.	
3	**Land Use Transport Modelling**		05
	3.1	Urban system components - Urban spatial structure – Accessibility - Location theory.	
	3.2	Land use models - Land use transport models, Lowry & Garin – Lowry models..	
4	**Transportation Economics**		10
	4.1	Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects	
	4.2	Basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs.	
5	**Urban Public Transport Planning**		05
	5.1	Growth history – Urban growth & public transport needs - Modes of public transport and comparison - Public transport travel characteristics	
	5.2	Technology of bus, rail, rapid transit systems, and basic operating elements. Transit characteristics - Fleet size and capacity estimation.	
6	**Parking Planning and Design**		05

	6.1	Types of Parking's, Methods of surveys, Parking inventories, Parking Design	
	6.2	Planning of parking for residential and commercial buildings including shopping complex, malls and multiplex.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Understand various Urban transport related terms and policies along with methods to carry out planning surveys.

2 Carry out trip generation, trip distribution, modal split and traffic assignment for planning of urban transport system.

3 Apply land use transport models at Urban area.

4 Carry out economic analysis of different Transport related Infrastructure projects by analyzing costs and benefits related to projects using NPV, IRR and B/C ratio method.

5 Estimate capacity of different public transportation modes in Urban area and to plan and schedule the same based on fleet size.

6 Plan and design Parking facility at Urban area.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only four questions need to be solved in total.

Recommended Books:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.
2. IRC: SP: 30-1993., Manual on Economic Evaluation of Highway Projects in India.
3. Sarkar P K., Maitri V.,Economics in Highway and Transportation Planning, Standard Publisher, New Delhi, 2010.
4. K.S. Ramegauda, Urban and Regional Planning, Mysore University Publication.
5. Ceder, A.,Public Transit Planning and Operation: Theory, Modeling and Practice, B-H Elsevier Ltd., MA, 2007.
6. IRC:SP:12-2015, Guidelines for Parking Facilities in Urban Roads

Reference Books:

1. Khisty C J., Lall B.Kent, Transportation Engineering – An Introduction, Prentice-Hall, NJ, 2005
2. Ortuzar, J. D., Willumsen, L.G., Modeling Transport, John Wiley & Sons, 1994
3. Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi,2002
4. Hutchinson B.G., Principles of Urban Transportation System Planning, Mc-Graw Hill, 1974.

Semester-V

Course Code	Course Name	Credits
CEDLO5017	Department Level Optional Course – I Advanced Concrete Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. Advancements in concrete technology is the backbone of infrastructure of civil engineering field. This course provides necessary knowledge about various concreting operations and testing operations during and after construction. This course is intended for gaining knowledge about the properties of materials, especially concrete and to maintain quality in construction projects. This course will also provide knowledge to the students about the criteria to be remembered during the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

1 To understand the various properties and tests of materials used in concrete along with the rheology of fresh concrete.

2 To study the different procedures for testing hardened concrete, its compositions and quality of in place concrete.

3 To understand the concept of durability and cracking in concrete. To also understand the significance and parameters of concreting under extreme environment and conditions.

4 To understand the concept and optimization of the mix design of concrete by various codes.

5 To study the various constituents, properties, significance and applications of special concrete.

6 To study the quality of concrete and check the acceptance criteria.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Constituents and Properties Of Concrete**		08
	1.1	Introduction of cement and water: Chemical composition of OPC, hydration, chemistry of cement, cement testing, water requirement for hydration, water quality for concrete and water quality test.	
	1.2	Aggregates: Types of aggregate (natural, synthetic, recycled), required characteristics of aggregates for concrete, introduction to gradation of aggregates, standard grading curve and gap grading.	
	1.3	Chemical admixture: Introduction to accelerators, retarders, plasticizers, super plasticizers, viscosity modifying admixtures, water proofers, miscellaneous admixtures.	
	1.4	Mineral admixture: Introduction, composition of mineral admixture, fly ash and its type, silica fume, ground granulated blast furnace slag and others. Effects of mineral admixture on fresh and hardened concrete properties.	
	1.5	Properties of fresh concrete: Introduction to properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, pumping of concrete.	
	1.6	Rheological models of fresh concrete: Introduction, simple flow test, rheological models and test methods, factors affecting rheological properties of concrete and effect of rheological properties on different types of concrete.	
2	**Testing of Concrete**		05
	2.1	Introduction to testing of hardened concrete - compression, tension, and flexure. Methods of testing (destructive, semi destructive, non-destructive).	
	2.2	Properties of hardened concrete: Factors influencing strength, importance of end effects in compression testing, tensile strength of concrete (split and flexural), relationship between compressive and tensile strength.	
	2.3	Advanced non-destructive evaluation: Ground penetration radar, probe test penetration, pull out/off, break off method, stress wave propagation method, electrical/magnetic methods, infrared thermography, and core test.	
3	**Durability of Concrete**		10
	3.1	Introduction to durability and permeability: Transport mechanism of fluids and gases in concrete, role of w/c and admixture on durability. Design of durability using performance specification.	
	3.2	Corrosion and carbonation: Introduction to corrosion of reinforcement in concrete, factors influencing corrosion, damages preventive measures of corrosion, tests for existing structures and remedial measures of corrosion, introduction and measurement of depth of carbonation.	
	3.3	Concrete structures in special environment: Frost action, fire or	

		high temperature, chemical attack and aggressive environment (sulphate attack, chloride attack, acid attack in sewers, sea water attack), alkali aggregate reaction (alkali silica and carbonate reaction).	
	3.4	Concreting under extreme weather: Hot and cold weather concreting, underwater concreting.	
4	**Concrete Mixture Design**		**07**
	4.1	Design of concrete mixes by IS 10262 (latest edition) Method – with and without fly ash, super plasticizer, effect of pumping of concrete on mixture design.	
	4.2	Design of concrete mixes by American Concrete Institute (ACI) Method – Air and non-air entrained concrete.	
	4.3	Design of concrete mixes by Department of Environment (DoE) Method.	
	4.4	Design of concrete mixes by Road note 4 Method.	
	4.5	Design of high strength concrete mixes using ACI 211.4R - 93 Method.	
5	**Special Concretes**		**06**
	5.1	Light weight concrete and ultra-light weight concrete: Types and properties of light weight aggregates, factors influencing the strength and density of light weight aggregate concrete, properties of light weight aggregate concrete. Introduction to other light weight concrete – Cellular and foamed concrete. (01).	
	5.2	High performance concrete: Methods for achieving high performance concrete, requirements for high performance characteristics, material selection, advantages and applications.	
	5.3	Self-compacting concrete (SCC): Materials for SCC, comparison of traditional and SCC constituents, requirements for SCC, initial mix compositions, production and placing of SCC, fresh concrete tests for SCC.	
	5.4	Fiber Reinforced Concrete (FRC): Study of different fibers (metallic fiber, polymeric fibers, carbon fibers, glass fibers, naturally occurring fibers) in concrete with respect to volume fraction, orientation and aspect ratio, physical and mechanical properties - steel and polypropylene fiber reinforced concrete. Applications of steel and polypropylene fibers reinforced concrete.	
	5.5	Introduction to other special concrete – Vacuum concrete, waste material-based concrete, shotcrete, roller compacted, mass concrete.	
6	**Quality Control (QC)**		**03**
	6.1	Introduction: Statistical QC, quality factors, control charts	
	6.2	Acceptance criteria according to Indian standards: Strength of concrete (site and laboratory)	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. To use the various concrete materials and demonstrate the fresh properties of concrete.
2. To perform different testing methods of concrete.
3. To describe the durability of concrete and apply the knowledge of durability in extreme weather concreting.
4. To design the concrete mix for field application by different methods.
5. To explain the various properties of special concrete.
6. To discuss the quality of concrete and explain the acceptance criteria.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only four questions need to be solved in total.

Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
5. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
6. Relevant I.S. codes: Bureau of Indian standard and ACI code.
7. Design of concrete mixes by N Krishna Raju (Latest Edition), CBS Publishers and Distributers Pvt. Ltd.

Reference Books:

1 Fibre Reinforced Cementitious Composites: Arnon Bentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.
2 Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999
3 Special Publication of ACI on Polymer concrete and FRC.
4 Concrete Technology: D.F. Orchardi, Wiley, 1962.
5 www.theconcreteportal.com

Semester-V

Course Code	Course Name	Credits
CEL501	Theory of Reinforced Concrete Structures (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To develop a clear understanding of design philosophy amongst the students for the design of reinforced concrete structures using working stress method (WSM) and limit state method (LSM).

2 To study various clauses of IS: 456-2000 and their significance in the RCC design.

3 To apply various concepts of LSM in the analysis and design of beams, slabs and columns.

4 To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.

5 To develop the concept of design using design charts and curves for columns subjected to axial load and moment.

6 To study the concept of reinforced concrete footing design subjected to axial load and moment.

Course Outcomes:

At the end of the course, learner will be able to:

1 Understand the fundamentals of WSM and LSM.

2 Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.

3 Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.

4 Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

List of Tutorials and Assignments		
Week (Activity)	**Detailed Content**	**Hours**
1st Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using WSM (Numericals Based on this module will be solved in tutorial class)	02
2nd Week (Assignment)	Analysis and Design of Singly and Doubly reinforced RCC beam using WSM or any one activity from below: Solve set of Questions given by the course instructor. Write a report on provisions in IS 456 2000 related to the design of beams A comparative study consisting of advantages and disadvantages of WSM and LSM	02
3rd Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. (Numericals Based on this module will be solved in tutorial class)	02
4th Week (Assignment)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse: Flexure.	02
5th Week (Tutorial)	Analysis and Design of Flanged beams for Flexure using LSM. Design of RCC beams in shear, bond, and torsion. (Numericals Based on this module will be solved in tutorial class)	02
6th Week (Assignment)	Analysis and Design of Flanged beams for Flexure using LSM. Or any one activity from below: Design of RCC beams in shear, bond, and torsion. Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse- Shear, Bond and Torsion.	02
7th Week (Tutorial)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000 (Numericals Based on this module will be solved in tutorial class)	02
8th Week (Assignment)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions on Design of RCC slabs.	02
9th Week (Tutorial)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. (Numericals Based on this module will be solved in tutorial class)	02
10th Week (Assignment)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. or any one activity from below: Solve set of Questions given by the course instructor. Studying the development of interactive curves and their use in column design.	02

	Study of IS: 456-2000 Provisions for Limit State of Collapse – Compression	
11th Week (Tutorial)	Design of Isolated square and rectangular footings subjected to axial load and moment. (Numericals Based on this module will be solved in tutorial class)	02
12th Week (Assignment)	Design of Isolated Square and rectangular footings subjected to axial load and moment. or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions related to design of RCC foundations. Report or presentation on Significance and Design of different types of RCC Foundations by various groups of students.	02
13th Week	Viva – Voce Examination	02

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus.

- **Recommended books:**

Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.

Limit State Design ofReinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee

Limit State Design ofReinforced Concrete: Shah and Karve, Structure Publications, Pune.

Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.

Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.

Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.

Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.

Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.

Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Semester-V

Course Code	Course Name	Credits
CEL502	Applied Hydraulics (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To describe the concepts of fluid dynamics and its applications.

2 To exemplify the fundamentals of impulse momentum principle and explain the working of various hydraulic machines.

3 To classify the uniform and non-uniform flow in open channel.

Course Outcomes:

At the end of the course, learner will be able to:

1 Evaluate the efficiencies and discuss the working of various pumps and turbines.

2 Apply impulse momentum principle to hydraulic machines.

3 Determine the rate of flow through open channel.

4 Generate and evaluate Gradually varied flow (GVF) and Rapid varied Flow (RVF) in open channel flow.

5 Compute the Chezy's Constant through tilting flume.

List of Experiments (Minimum Six)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Impact of jet, flat plate, inclined plate, curved vanes.	02
2	Performance of Pelton turbine.	02
3	Performance of Francis Turbine.	02
4	Performance of Kaplan Turbine.	02
5	Performance of Centrifugal pumps.	02
6	Chezy's roughness factor.	02
7	Specific energy.	02
8	Hydraulic Jump.	02
9	Calibration of Broad crested weir/Venturi flume.	02

Assessment:

- **Term Work**

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise. The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

1 Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company.
2 Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.
3 Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, Dhanpat Rai Publishing Company (P) Ltd-New Delhi.
4 Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
5 Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.
6 Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.
7 Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Semester-V

Course Code	Course Name	Credits
CEL503	Geotechnical Engineering – I (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 Determination of moisture content, specific gravity of soil solids and in-situ field density of soils as well as field identification of fine-grained soils

2 To determine the grain size distribution of soils and consistency or Atterberg limits of fine-grained soils

3 To determine coefficient of permeability of soils in laboratory

4 To determine compaction characteristics of soils in laboratory

5 To determine the density index (relative density) of cohesionless soil

6 To determine field SPT 'N' value by Standard Penetration Test

Course Outcomes:

At the end of the course, learner will be able to:

1 Determine the physical and engineering properties of soil

2 Determine the plasticity characteristics of soil

3 Carry out sieve analysis of soil, plot grain size distribution curve and determine the IS classification of soil

4 Determine coefficient of permeability of soils

5 Determine the compaction characteristics of soils

6 Compute the field SPT 'N' value and prepare the bore log

List of Experiments (Minimum ten)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Determination of natural moisture content of soil using oven drying method Following other methods to find moisture content shall be explained briefly: a) Pycnometer method b) Sand bath method c) Alcohol method d) Torsional balance method e) Moisture meter f) Radio activity method	02
2	Specific gravity of soil grains by density bottle method or Pycnometer method	02
3	Field density using core cutter method	02
4	Field density using sand replacement method	02
5	Field identification of fine-grained soils	02
6	Grain size distribution of coarse-grained portions (gravel and sand) of soil by sieve analysis	02
7	Grain size distribution of fine portions (silt and clay) of the soil by Hydrometer analysis	02
8	Determination of liquid (Casagrande method), plastic and shrinkage limits	02
9	Determination of liquid limit by cone penetrometer method	02
10	Determination of co-efficient of permeability using constant head method	02
11	Determination of co-efficient of permeability using falling head method	02
12	Compaction test, IS light compaction test/ Standard Proctor test	02
13	Compaction test, IS heavy compaction test/ Modified Proctor test	02
14	Relative density (or, density index) test	02
15	Standard penetration test	02

Assessment:

- **Term Work**

a) The term work shall be comprised of the neatly written reports based on the experiments performed in the laboratory, assignments, attendance and case study.

b) The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each module/ sub-module.

c) Students (5 students max. in a group) should perform a case study on Forensic Investigation for Geotechnical Failures/or, Geo environmental Engineering and must submit a report or power point presentation on the same. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission.

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the laboratory works, assignments, attendance and case study. The final certification acceptance of term work warrants the satisfactory and appropriate completion of laboratory work, assignments and case study with the minimum passing marks by the students. The following weightage of marks shall be given for different components of the term-work.:

Laboratory Work : 12 Marks
Case study : 03 Marks
Assignments : 05 Marks
Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

The oral examination shall be based upon the entire theory and laboratory syllabus.

Reference Books:

1 SCI/SCOPUS Indexed Refereed International Journals (For Case Studies)
2 Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.
3 Departmental Laboratory Manual
4 Standard Geotechnical Engineering Handbook
5 NPTEL Video lectures on Practical.

Semester-V

Course Code	Course Name	Credits
CEL504	Transportation Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objective:

1 To determine Penetration grade and Viscosity grade of bitumen.

2 To find the Softening point and Ductility value of bitumen.

3 To determine Impact, Abrasion and Crushing value of aggregate.

4 To carry out shape test on aggregates.

5 To carry out Classified volume study and plot speed profile at mid-block section.

Course Outcomes:

At the end of the course, learner will be able to:

1 Classify Bitumen on basis of Penetration and Viscosity grade.

2 Select Bitumen as per suitability on basis of Softening point and Ductility value.

3 Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.

4 Differentiate Elongated and Flaky aggregates on basis of Shape test.

5 Carry out Classified volume study at mid-block section of road.

6 Plot speed profile curve (S-Curve) at mid-block section.

List of Experiments (Minimum Eight)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Penetration Test on Bitumen.	02
2	Viscosity Test on Bitumen.	02
3	Softening Point Test on Bitumen	02
4	Ductility Test on Bitumen	02
5	Determination of Aggregate Impact Value	02
6	Determination of Aggregate Crushing Value	02
7	Determination of Abrasion Value of Road Aggregate	02
8	Shape Test of Aggregate	02
9	Classified Volume count at mid-block section	02
10	Speed profile study at mid-block section	02

Assessment:

- **Term Work**

Including Laboratory Work Survey project report and Assignments, Distribution of marks for Term Work shall be as follows:

Laboratory Work and Traffic Survey	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral exam will be based on experiments performed, traffic survey carried out and theory syllabus.

Reference Books:

1 Highway Engineering: Khanna, S.K. and Justo, C. E. G.;Nem Chand and Bros., Roorkee.
2 Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
3 Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.
4 Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi
5 Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publsihers, Delhi.
6 Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEL505	Professional Communication and Ethics-II	02

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
---	02*+02	-	-	02	-	02

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Rationale

This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.

Course Objectives

1 Discern and develop an effective style of writing important technical/business documents.

2 Investigate possible resources and plan a successful job campaign.

3 Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.

4 Develop creative and impactful presentation skills.

5 Analyze personal traits, interests, values, aptitudes and skills.

6 Understand the importance of integrity and develop a personal code of ethics.

Course Outcomes

Learner will be able to

1 Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.

2 Strategize their personal and professional skills to build a professional image and meet the demands of the industry.

3 Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.

4 Deliver persuasive and professional presentations.

5 Develop creative thinking and interpersonal skills required for effective professional communication.

6 Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Advanced Technical Writing: Project/ Problem Based Learning (PBL)**		06
	1.1	**Purpose and Classification of Reports, Classification on the basis of:** Subject Matter (Technology, Accounting, Finance, Marketing, etc.); Time Interval (Periodic, One-time, Special); Function (Informational, Analytical, etc.); Physical Factors (Memorandum, Letter, Short & Long)	
	1.2	**Parts of a Long Formal Report** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports**: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals**: Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** Elements: Scope and Limitations, Conclusion	
	1.6	**Technical Paper Writing**: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	
2	**Employment Skills**		06
	2.1	**Cover Letter & Resume:** Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose:** Importance of SOP, Tips for Writing an Effective SOP	
	2.3	**Verbal Aptitude Test:** Modelled on CAT, GRE, GMAT exams	
	2.4	**Group Discussions:** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes	
	2.5	**Personal Interviews:** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	

3	**Business Meetings**		02
	3.1	**Conducting Business Meetings:** Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	
	3.2	**Documentation**: Notice, Agenda, Minutes	
4	**Technical/ Business Presentations**		02
	4.1	**Effective Presentation Strategies**: Defining Purpose, Analysing Audience, Location and Event, Gathering, Selecting & Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	
	4.2	**Group Presentations**: Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5	**Interpersonal Skills**		08
	5.1	**Interpersonal Skills**: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	
	5.2	**Start-up Skills:** Financial Literacy, Risk Assessment, Data Analysis (e.g., Consumer Behaviour, Market Trends, etc.)	
6	**Corporate Ethics**		02
	6.1	**Intellectual Property Rights:** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)	
	6.2	**Case Studies:** Cases related to Business/ Corporate Ethics	
		Total	**26**

List of Assignments for Term Work

In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.

1 Cover Letter and Resume
2 Short Proposal
3 Meeting Documentation
4 Writing a Technical Paper/ Analysing a Published Technical Paper
5 Writing a SOP
6 IPR
7 Interpersonal Skills
8 Aptitude test (Verbal Ability)

Note:

- The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
- The group size for the final report presentation should not be less than 5 students and not to exceed more than 7 students.
- There will be an end–semester presentation based on the book report.

Assessment:

- **Term Work**

Term work shall consist of minimum 8 experiments.

Assignments	:	10 Marks
Presentation Slides	:	05 Marks
Book Report (Hard Copy)	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

- **Internal Oral**

Oral Examination will be based on a GD & the Project/Book Report presentation

Group Discussion	:	10 Marks
Individual Presentation	:	10 Marks
Group Dynamics	:	05 Marks

Recommended Books:

1 Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/ Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.

2 Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.

3 Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.

4 Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.

5 Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.

6 Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press

7 Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press

8 Sanjay Kumar & Pushp Lata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Semester-V

Course Code	Course Name	Credits
CEM501	Mini Project -2A	2

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	04	-	-	2	-	2

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Rationale

From primitive habitats of early years to modern buildings, the civil engineering industry's growth has been needing based and society centric. Civil engineers deal with many challenges on daily basis that most people do not have any idea. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their books and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

1 To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.

2 To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.

3 To examine and break information into parts, by analyzing motives or causes.

4 To learn evaluating information, validity of ideas and work based on a set of criteria.

5 To create solutions by compiling information together in a different way.

6 To design model by combining elements in a new pattern or proposing new solutions.

Course Outcomes:

At the end of the course, learner will be able to:

1 Identify problems based on societal /research needs and formulate a solution strategy.

2 Apply fundamentals to develop solutions to solve societal problems in a group

3 Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.

4 Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.

5 Draw the proper inferences from available results through theoretical/ experimental/ simulations and assemble physical systems.

6 Create devises or design a computer program or develop computer application.

- **Guidelines for Mini Project -2A**

Expected outcome is hardware based, "A Working Model."

Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

Students should find 'List of Mini project – 2A problems' in University web portal www.mu.ac.in, and in consultation with faculty supervisor/ head of department/ internal committee of faculties select the title.

Students shall submit implementation plan in the form of Gant/ PERT/ CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/ comments.

Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that Students come out with original solution.

However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/ modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2A:	
H501:	Construction of Model showing New application of alternative materials and byproducts of different industries for Durability and sustainability.
H502:	Construction of Model/ device for Smart Traffic Management System Using Internet of Things
H503:	IOT based smart device for traffic signal monitoring system using vehicle Count.
H504:	Mini Project on Construction of Model showing New application of use of Fly Ash in Civil Engineering works.
H505:	Mini Project on specimen of Modified Concrete Pavements (using unconventional, recycled or waste product)
H506:	Novel device for Base isolation system for multistoried building
H507:	Mini project on specimen of light transmitting concrete.
H508:	Model of Novel Seismic isolation devices for bridge structures.
H509:	Novel Applications of Bamboo as a building material specimen.
H510:	Development of device using sensors for deflection of girders. Beams, slabs or bridges.
H511:	Development of device using sensors for detection of fracture in Railway tracks.
H512:	Mini project on specimen of Bubble deck slab.
H513:	Construction of specimen of GFRG panels as walls in buildings instead of conventional walls.
H514:	Construction of specimen of Agro waste reinforced panels as walls in buildings instead of conventional walls.
H515:	Construction of specimen of unconventional panels as walls in buildings instead of conventional walls.
H516:	Construction of specimen of Ferro cement Slab as a replacement to RCC slab.
H517:	Construction of specimen of No Fines Concrete or porous Concrete and its applications.
H518:	Construction of Model of Novel Soil Stability technique to prevent landslides.
H519:	Construction of Model of a dwelling unit (house) in rural area.
H520:	Typical design of Model for construction of toilets in rural India.
H521:	Construction of Model for Typical applications of Ferro concrete.
H522:	Construction of Model of road paths with locally sourced materials in villages.
H523:	Construction of Model showing Typical application of Prestressed concrete.
H524:	Construction of Model showing Typical application of fiber reinforced concrete.

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

- **Term Work**

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book	:	10 Marks
Marks awarded by review committee	:	10 Marks
Quality of Project report	:	5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **One-year project:**

  Only if a project is very demanding it will be considered for 'One Year Project'. Subject to approval by the Head of the department.

  Outcome shall be a 'Hardware and a software based' solution

  There shall also a 'technical paper' to be presented in conference/published in journal (UGC approved) or student's competition.

  In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

  First shall be for finalization of problem

  Second shall be on finalization of proposed solution of problem.

  In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

  First review is based on readiness of building working prototype to be conducted.

  Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

- **Half-year project:**

  In this case in one semester students' group shall complete project in all aspects including

  Identification of need/problem

  Proposed final solution

  Procurement of components/systems

  Building prototype and testing

  Two reviews will be conducted for continuous assessment,

  First shall be for finalization of problem and proposed solution.

  Second shall be for implementation and testing of solution.

- **Assessment criteria of Mini Project:**

  Mini Project shall be assessed based on following criteria:

  Quality of survey/ need identification
  Clarity of Problem definition based on need.
  Innovativeness in solutions
  Feasibility of proposed problem solutions and selection of best solution
  Cost effectiveness
  Societal impact
  Innovativeness
  Cost effectiveness and Societal impact
  Full functioning of working model as per stated requirements
  Effective use of skill sets
  Effective use of standard engineering norms
  Contribution of an individual as member or leader
  Clarity in written and oral communication

  In one year, project, first semester evaluation may be based on first six criteria and remaining may be used for second semester evaluation of performance of students in mini project.

  In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

  Report should be prepared as per the guidelines issued by the University of Mumbai.

  Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.

  Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

- **Mini Project shall be assessed based on following points:**

  Quality of problem and Clarity
  Innovativeness in solutions
  Cost effectiveness and Societal impact
  Full functioning of working model as per stated requirements
  Effective use of skill sets
  Effective use of standard engineering norms
  Contribution of an individuals as member or leader
  Clarity in written and oral communication

Semester VI

Semester-VI

Course Code	Course Name	Credits
CEC601	Design and Drawing of Steel Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	4 Hours	-	-	-	100

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil Engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. I.S. code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

1 To make students familiar with behavior of steel structure and their components under the action of various loads.
2 To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
3 To help students design connections of steel members.
4 To equip students with aspects required for designing tension member, compression members and column bases.
5 To equip students with aspects required for designing of flexural members.
6 To aid students in designing steel trusses.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction**		03
	1.1	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Advantages and limitations of WSM, permissible stresses in WSM. Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.	
2	**Design of Bolted And Welded Connections**		06
	2.1	Design of bolted and welded connections for axial force, beam to beam and beam to column connections. Framed, stiffened and unstiffened seat connections, bracket connections.	
3	**Design of Tension Members**		04
	3.1	Introduction, types of tension members, net area calculation.	
	3.2	Design strength due to yielding, rupture and block shear.	
	3.3	Design of tension members with welded and bolted end connection using single angle section & double angle section.	
4	**Design of Compression Members and Column Bases**		11
	4.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	4.2	Design of axially loaded column using rolled steel sections, design of built-up column, laced and battened Columns.	
	4.3	Design of slab bases & gusseted base.	
5	**Design of Flexural Members**		11
	5.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection.	
	5.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment	
6	**Design of Truss**		04
	6.1	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing. Design of angle section purlin.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Use the knowledge of Limit State Design philosophy as applied to steel structures. IS 800 code clauses
2 Design bolted and welded connections.
3 Design members subjected to axial tension.
4 Design compression members, Built-up columns and column bases.
5 Design members subjected to bending moment, shear force etc.
6 Estimate design loads as per IS 875 for roof truss and design the Steel roof truss.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total Five questions. $\{(\mathbf{32 + (4 \times 16)}\}$
2 Question 1 will be compulsory carrying 32 marks and should be based on steel design project.
3 Remaining questions will be carrying 4×16 marks, mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. Only three questions carrying 16 marks need to be solved.
4 Total Four questions need to be solved. (32+16+16+16)
5 In end semester examination, students will write answers in answer booklet and draw sketches on half imperial drawing sheet.
6 **Use of relevant IS codes shall be allowed in the examination**

Recommended Books:

1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
3 Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.
4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi
7 Limit state design of steel structure by Dr. V.L. Shah and Gore, Structure publication Pvt. Pune.

Reference Books:

1 Design of Steel Structure by Allen Williams

2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing

3 Structurai design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.

4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEC602	Water Resources Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This course provides necessary knowledge and information about various irrigation methods as well as water requirements of crops, hydrologic processes, control level fixation of dams and reservoirs and hydraulics of wells. In addition to this, it provides necessary knowledge about analysis and design of gravity dams and earthen dams, different silt theories related to irrigation channels, detailed classification of canal head-works and its distribution system and finally discusses about different canal structures and cross drainage works.

Objectives

1 To study different irrigation engineering methods and water requirement of crops.

2 To study hydrological cycle, its elements and plotting of hydrographs.

3 To study and calculate discharge from aquifers.

4 To study control level fixation for reservoir, Dams i.e., gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.

5 To study importance of silt theories and its design considerations.

6 To study Canal headwork, its distribution system and design of canal structures.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Irrigation Methods and Water Requirement of Crops**		07
	1.1	National water policy. Introduction to irrigation and need of irrigation, Benefits of irrigation and ill effects of irrigation, types of Irrigation Projects: minor, medium and major irrigation projects and National water policy.	
	1.2	Methods of Irrigation Systems: Surface irrigation and different techniques of water distribution for surface irrigation, Subsurface irrigation, sprinkler irrigation and drip irrigation.	
	1.3	Water Requirement of Crops: Crops and crop seasons in India, delta and duty of crops, relationship between delta and duty of crops. Soil water relationship and its significance from irrigation considerations, root zone soil water, infiltration, consumptive use, frequency of irrigation.	
2	**Hydrology**		07
	2.1	Hydrologic cycle, Precipitation: Forms and Types of precipitations.	
	2.2	Measurement of rainfall by rain gauges and stream flow measurement. calculation of missing rainfall data and adequacy of rain gauge stations.	
	2.3	Runoff: Runoff- factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, flood discharge and its calculations.	
	2.4	Hydrograph: Flood hydrograph- Its components and base-flow separation, Unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph and its application.	
3	**Ground Water and Well Hydraulics**		05
	3.1	Ground water resources and occurrence of ground water.	
	3.2	Well hydraulics: steady state flow conditions in wells.	
	3.3	Equilibrium equations for confined and unconfined aquifer.	
	3.4	Aquifer tests.	
	3.5	Difference between open well and tube well, Well Losses	
4	**Dams and Spillways**		09
	4.1	Reservoir, various zones of storage reservoir, control level fixation for a reservoir Introduction to reservoir sedimentation and control measures.	
	4.2	Gravity Dams: Definition, typical cross section and components of gravity dam, forces acting on gravity dam, modes of failure	

		of gravity dam, structural stability analysis of gravity dam, elementary and practical profile of gravity dam, low and high gravity dam, galleries in gravity dam – Function of gallery and different cross-sections of gallery adopted in practice, joints in gravity dam. control of cracking in concrete dams.	
	4.3	Earthen Dam: Types of earthen dams and methods of construction of earthen dam, causes and failures of earthen dams, seepage line/phreatic line for different conditions and its location using graphical method, seepage control through embankment and through foundations.	
	4.4	Spillways: Introduction, types of spillways – its working and functionality.	
5	**Irrigation Channels (Silt Theories)**		06
	5.1	Kennedy's theory and method of channel designs silt supporting capacity according to Kennedy's theory.	
	5.2	Lacey's regime theory and application of Lacey's theory for designing channel cross-section.	
	5.3	Comparison between Kennedy's theory and Lacey's theory.	
	5.4	Drawbacks of Kennedy's theory and Lacey's theory.	
	5.5	Introduction to sediment transport in channels.	
6	**Canal Headwork-Distribution System and Canal Structures**		05
	6.1	Canal Headwork and Distribution System: Classification of canals, canal alignment, canal losses, canal lining, water logging and remedial measures for water logging.	
	6.2	Canal Structures Canal Falls and types of canal falls, canal escapes and types of canal escapes, canal regulators and types of canal regulators, canal outlets and types of canal outlets, cross drainage works and types of cross drainage work.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Describe National water Policy, Calculate Crop water requirement and Classify various types and methods of irrigation.

2 Estimate flood discharge and Runoff by traditional and modern usage tools for planning and management of water resources projects.

3 Apply knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential

4 Analyze and design gravity dams and earthen dams with spillways for sustainable development

5 Compare different silt theories related to irrigation channel and design the same.

6 Classify and Explain various canal structures and suggest remedial measures for water logging to save fertile irrigation

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.

Recommended Books:

1 Irrigation and Water Power Engineering: B.C. Punmia, PandeB.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
2 Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
3 Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4 Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5 Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
6 Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
7 Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
8 Design of Small Dams: USBR.
9 Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
10 Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester VI

Course Code	Course Name	Credits
CEC603	Geotechnical Engineering-II	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers, more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative consultancy work and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

1 Students will gain knowledge of consolidation theory.

2 Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.

3 Students will analyze stability of slopes.

4 Students will analyze and evaluate lateral earth pressure.

5 Students will analyze and design shallow foundation.

6 Students will analyze and design deep foundation.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Module Name- Consolidation of soils**		**06**
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion, recompression indices, normally and over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation (no proof)- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor and degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	**Module Name- Shear strength**		**05**
	2.1	Introduction, frictional cohesive strength, state of stresses in soil mass, principal stresses, determination of stresses on an inclined plane by using analytical and Mohr's circle method, important characteristics of Mohr's circle.	
	2.2	Coulomb theory, Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure envelope- relation between major and minor principal stresses, total & effective stress analysis.	
	2.3	Different types of drainage conditions UU, CU and CD: Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves.	
	2.4	Determination of shear strength of soil- pull out test and Introduction to liquefaction of Soils.	
3	**Module Name- Stability of Slopes**		**06**
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety.	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage condition along the slope.	

	3.3	Stability analysis of finite slopes: i) Taylor's stability number ii) friction circle method iii) Swedish circle.	
4	**Module Name - Lateral Earth Pressure Theories**		08
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine's earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb's wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann's Graphical Method (no proof)	
	4.5	Culmann's Graphical Method (no proof)	
5	**Module Name- Shallow Foundations**		08
	5.1	Introduction: types of shallow foundations, definitions of different bearing Capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi's theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi's theory ii) Vesic's theory: bearing capacity equation I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6	**Module Name- Pile Foundations**		06
	6.1	Introduction to pile foundations: necessity of pile foundations, types of pile foundation.	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load carrying capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
		Total Hours	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Evaluate the consolidation parameters for the soil.
2 Calculate the shear strength parameters for the soil.
3 Calculate the factors of safety of different types of slopes under various soil condition, analyze the stability of slopes.
4 Calculate lateral earth pressure under various soil condition.
5 Calculate bearing capacity of shallow foundations using theoretical and field methods.
6 Calculate load carrying capacity of individual as well as group of pile foundation using theoretical and field methods and pile settlement.

Internal Assessment (20 Marks):

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of the two will be considered as IA marks.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total **six questions, each carrying 20 marks.**
2 **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3 **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only **Four questions need to be solved.**

Recommended Books:

1 Soil Mechanics and Foundation: Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications
2 Soil Mechanics and Foundation Engineering: K.R. Arora; Standard publishers and Distributors
3 Soil Mechanics and Foundation Engineering: V.N.S Murthy; Saitech Publications
4 Geotechnical Engineering: C. Venkatramaiah; New age International
5 Theoretical Soil Mechanic: K. Terzaghi; John Wiley and Sons
6 Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and sons
7 Relevant Indian Standard Specification Code: BIS Publications, New Delhi
8 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House
9 Geotechnical Engineering: Purushothama Raj; Tata McGraw Hill Publications
10 Basic and Applied Soil Mechanic: Gopal Ranjan and A.S. Rao; New Age International

Semester-VI

Course Code	Course Name	Credits
CEC604	Environmental Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Every civil engineer must be acquainted with the principles of public health engineering, purification of water, sewage collection, design of water and sewage treatment and develop rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of water, building drainage, rain water harvesting, sewage treatment processes and solid waste management. The course also lays emphasis on the knowledge of Air and Noise pollution.

Objectives

1 To demonstrate the necessary knowledge and concepts in the fields of water supply and quality of water.

2 To impart necessary skill for the design and operation of various units of water treatment facilities.

3 To recognize the necessary knowledge of good plumbing system, building drainage and rainwater harvesting.

4 To demonstrate the necessary knowledge on domestic sewage and Sewerage system.

5 To develop a flow Content for sewage treatment and design its units.

6 To impart the basic understanding of Air pollution, noise pollution and solid waste so as to control its adversity on ambient environment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Water Supply and Quality Of Water**		04
	1.1	Water supply: Water supply systems, water resources, types of intake structures, distribution systems of water and distribution layouts.	
	1.2	Quality of water: Introduction to pure water: potable, wholesome, palatable, distilled, polluted and contaminated water, drinking water standards and characteristics of water, water borne diseases.	
2	**Water Treatment**		15
	2.1	WTP: Typical layout of WTP, Aeration, Types of Aeration systems, sedimentation, types of settling, tube settlers, design of sedimentation tank.	
	2.2	Coagulation and flocculation: Principle of coagulation, flocculation, Clari flocculator, coagulants aids.	
	2.3	Filtration: rapid sand filters, operation, cleaning and back-washing, Entire design of rapid gravity filter with under drainage system. Pressure filter: Construction and operation	
	2.4	Disinfection: Different methods of disinfection, chlorination and chemistry of chlorination, chlorine demand, free and combined chlorine, various forms of chlorine, types of chlorination. Numerical to calculate quantity of required chlorine doses.	
	2.5	Advanced and Miscellaneous Treatments: Water softening by lime soda process and by base exchange method, Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese.	
3	**Building Water Supply, Drainage and Rainwater Harvesting**		04
	3.1	Building water supply: Water demands, Per capita Supply, Service connection from main, Water meter.	
	3.2	Building drainage: basic principles, traps-types, location and function, Systems of Plumbing, anti siphonic and vent pipes.	
	3.3	Rainwater harvesting: Need for rainwater harvesting, Annual potential, Roof-top rain water harvesting. Numerical on annual rainwater harvesting potential.	

4		**Domestic Sewage and Sewerage System:**	08
	4.1	Sewage: Introduction to domestic sewage, and storm water, System of sanitation, Physical and chemical characteristics, decomposition of sewage, BOD, COD, numerical on BOD. MPCB norms for disposal of sewage effluent.	
	4.2	Sewerage system: Systems of sewerage and their layouts: Separate, Combined and partially combined system, merits and demerits, self-cleaning velocity and non-scouring velocity, Sewer- Shape, hydraulic design of sewers, Laying and testing of sewers, manhole-location, necessity, types and drop manhole, ventilation	
5		**Sewage Treatment**	15
	5.1	Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
		Secondary Treatment Methods: Trickling filter- Principle, Process description and Design of trickling filter. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, (numerical), Sludge volume index.	
	5.2	Introduction to Biological Treatment: Aerated lagoons, Oxidation ponds, oxidation ditches.	
		Self-purification of natural waterbodiess: Oxygen economy, Disposal of treated effluent. Disposal of Raw and treated sewage on land and water, DO sag curve.	
	5.3	Rural and Low-cost sanitation: Septic Tank and Soak Pit – Operation, suitability and Design	
6		**Air Pollution, Noise Pollution and Municipal Solid Waste Management**	06
	6.1	Air pollution: Composition of air, Quantification of air pollutants, Air quality standards, Effect of air pollution on Environment, Introduction to Air pollution control devices.	
	6.2	Noise pollution: Basic concept and measurement, Effects of noise, and control methods, and numerical on sound level.	
	6.3	Municipal Solid Waste Management: Sources, storage, treatment, disposal,5R Principles.	
		Total	**52**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Analyse the quality of water and make outline of water Supply scheme.
2 Design the various units of water treatment plant and apply the advanced, miscellaneous treatments whenever necessary.
3 Build service connection of water supply from main and building drainage system at construction site along with rain water harvesting layout.
4 Analyse and plan sewerage system along with test for sewer line.
5 Design the units of sewage treatment plant. Also, able to apply the knowledge of low-cost treatment and stream sanitation.
6 Understand air pollution, noise pollution and functional elements of solid waste management.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Site Visit:

The students will visit to sewage treatment plant/ water treatment plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work

Recommended Books:

1 Water Supply Engineering: S. K. Garg, Khanna Publication.
2 Water Supply Engineering: P.N. Modi, Rajsons Publication.
3 Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi
4 Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan
6 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: *S. K. Garg*, Khanna Publishers New Delhi
7 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian
8 Integrated solid waste management, Tchobanoglous. Theissen and Vigil, McGraw Hill Publication.

Reference Books:

1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
2 Plumbing Engineering, Theory and Practice: *Patil S. M.*, Seema Publication, Mumbai.
3 Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.
4 Water Supply and Sewerage: *E. W. Steel.*
5 Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi.
6 Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.
7 CPHEEO Manual on Water Supply and Treatment.
8 CPHEEO Manual on Sewage and Treatment.
9 Environmental Engineering: Peavy,H.S., RoweD.R., TchobanoglousG.; 1991, Tata-Mcgraw Hill.

Semester-VI

Course Code	Course Name	Credits
CEDLO6011	Department Level Optional Course -2 Rock Mechanics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The Civil Engineering structures are built on or through rocks. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of deformation resulting from the strain of rocks in response to various stresses working on them. The mechanisms and character of the deformation of rocks can be investigated through laboratory experiments. The course will give an idea of in- situ testing of the rock and observation of geological conditions that can affect the way a rock behaves when subjected to loads and stresses.

Objectives

1 To provide basic knowledge of Rock -Mechanics to understand design aspects of various structures on or through rocks.

2 To study the various classification schemes of rock masses and their application.

3 To study the physical properties of rocks and various lab test conducted on them to determine the strength.

4 To determine properties and behavior of various types of rock under different loading conditions.

5 To study bearing capacity, stress distribution and factor of safety within the rock.

6 To study the stability of rock slopes and design aspects of openings in/on the rocks.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Structural Geology and Data Interpretation**		05
	1.1	Introduction to Rock Mechanics and Importance	
	1.2	Geological classification of rocks	
	1.3	Description of discontinuities and their effect on rocks	
	1.4	Stereographic Analysis of structural Geology	
2	**Engineering Classification of Rocks and Rock Masses:**		06
	2.1	Classification of intact rocks. Rock mass classifications: Rock Quality Designation (RQD), Rock Structural Rating (RSR), Rock Mass Quality (Q system).	
	2.2	Strength and Modulus from classifications, classification based on Strength and Modulus.	
	2.3	Geo-mechanics (RMR)} and Geo-engineering classification	
	2.4	Deere and Miller's Engineering Classification	
3	**Laboratory Testing of Rocks: Field and Laboratory Tests on Rocks**		07
	3.1	Determination of physical properties of rocks	
	3.2	Uniaxial Compressive Strength Test	
	3.3	Tensile Strength Test	
	3.4	Direct Shear Test and Triaxial Test	
	3.5	Slake Durability Test	
	3.6	Schmidt Rebound Hardness, Swelling Pressure and Free-Swell, Void Index, Hydraulic fracture, Flat Jack Test	
4	**Strength, Modulus and Stress-Strain Responses of Rocks:**		07
	4.1	Factors influencing rock responses, Strength criteria for isotropic intact rocks, Modulus of isotropic intact rocks.	
	4.2	Uni-axial Compressive Strength of intact anisotropic rocks, Strength due to induced anisotropy in rocks, Compressive Strength and Modulus from SPT.	
	4.3	Stress- strain models (constitutive models, elastic stress-strain model, elastic-plastic stress-strain model, Visco-elastic Model.	
5	**Bearing Capacity of Rocks:**		06
	5.1	Estimation of bearing capacity (foundation on intact rock, heavily fractured rock), UBC with Hoek-Brown criterion, foundation on slope	
	5.2	Stress distribution in rocks, Factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned	

		cable anchors, concrete block at e),	
	5.3	Settlement in rocks (from joint actor, for horizontal joints, from field tests).	
6	**Stability of Rock Slopes & Opening i Rocks**		08
	6.1	Modes of failure, rotational f lure, plane failure, wedge method of analysis, bucklin failure, toppling failure, application of stereographic proj ction, Remedial measures.	
	6.2	Rock Bolting and Grouting: M ods to improve rock mass responses, grouting in rocks, jectives, contact grouting, consolidation grouting, process grouting, grout requirement, types of grout, stage grouting, gr curtain. Rock Bolting Rock anchors.	
	6.3	Tunneling: Ground condition in tunneling, Computing structural discontinuities in rock asses, requirement of lining in tunnels, pressure tunnels an tunnels for other purposes, application of stereographic proj tion.	
		Total	**39**

Contribution to C tcome

On completion of this course, the students will be a e to:

1 Explain basic concepts of Rock -Mechanics d apply it to design aspects of various Civil Engineering structures on or through th ocks.
2 Classify the rock masses and evaluate them f various Civil Engineering works.
3 Explain the laboratory testing of rocks and d rmine the physical properties and strength of intact rocks and rock masses.
4 Explain the stress-strain responses of the roc and influencing factors.
5 Determine the bearing capacity and factor of fety of rocks.
6 Determine the stability of slopes and undergr nd excavations.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents a second test based on remaining contents (approximately 40% but excluding contents covere in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester exam ation will be proportional to number of respective lecture hours mentioned in the curricul .

1 Question paper will comprise of total six que ions, each carrying 20 marks.
2 Question 1 will be compulsory and should co er maximum contents of the curriculum.
3 Remaining questions will be mixed in nature or example if Q.2 has part (a) from module 3 then part (b) will be from any mod e other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Introduction to Rock Mechanics: Goodman, RE (1989), Canada, Jhon Wiley & Sons.
2 Rock Slope Engineering, Hoek, E and Bray, JW (1977), The Institution of Mining and Metallurgy, London.
3 Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall.*
4 Engineering Rock Mass Classification, Singh, B and Goel RK (20011), Oxford, UK, Elsevier Inc.

Reference Books:

1 Rock Mechanics in Engineering Practice: *K. G. Stagg and O. C. Zienkiewicz*, John Willey and Sons, New York.

2 Rock Mechanics – Vol. I and II: *Jumukis*, Trans Tech Publication, USA.

3 Fundamentals of Rock Mechanics: Jaeger, JG, Cook, NGW and Zimmerman, RW (2007) 4 th Ed., Singapore, Blackwell Publishing

4 Rock Mechanics and Design of Structures on Rock: Obert, Leon and W. I. Duvall.

Semester-VI

Course Code	Course Name	Credits
CEDLO6012	Department Level Optional Course - 1 Biological Process and Contamination Removal	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Biological treatment processes are widely used in both developed and developing countries to control and accelerate the natural process of organic matter decomposition. The process is often used to treat biodegradable waste materials released from domestic, commercial and industrial sources before they are disposed of. However, it is also observed to further treat the wastewater for contamination removal in order to remove and treat toxic materials. The course deals with the overall features and study of biological treatments of wastewater and contamination removal. The course lays emphasis on complete updates of these processes and knowledge related to design of treatment units.

Objectives

1 To understand quality, quantity, characteristics and treatment process of wastewater generated from various sources

2 To understand the biological process and treatment of wastewater.

3 To provide students the necessary knowledge and concepts of advancements/ emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies

4 To study and design the aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems.

5 To study and design the anerobic decomposition and its application in wastewater treatment.

6 To develop rational approaches towards natural and biotechnological methods for contamination removal.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Waste Water Generation, Collection and Conveyance**		**08**
	1.1	Introduction: Domestic waste water, Industrial Wastewater and Stormwater, Conservancy and Water carriage system, Systems of sewerage, Quantity and Quality of Wastewater.	
	1.2	Need for Analysis, Characteristics of wastewater: Analysis of wastewater, Characteristics of wastewater and sampling, Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition,	
	1.3	Waste Water Treatment and Flow diagram: Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Waste Water Treatment Plant and Effluent Treatment Plants. Various combinations and options. Low-cost treatment plant.	
2	**Introduction to Biological Treatment:**		**03**
	2.1	Overview of biological wastewater treatment, objectives of the treatment, role of microorganisms, types of biological processes for wastewater treatment, suspended and attached growth systems.	
3	**Microbial Growth Kinetics**		**06**
	3.1	Microbial Growth Kinetics terminology, rate of utilization of soluble substrates, rate of biomass growth with soluble substrate, rate of oxygen uptake, effects of temperature, total volatile suspended solids and active biomass, net biomass yield and observed yield.	
	3.2	Biotechnological remedies - Bio-fertilizers, Physical, chemical and Microbiological factors of composting, Health risk – Pathogens, Odor management, Microbial cell/enzyme technology, Adapted microorganisms, Biological removal of Nutrients.	
4	**Aerobic Decomposition:**		**08**
	4.1	Aerobic Suspended Growth Biological Treatment Systems: Aerobic biological oxidation, process description, environmental factors, Modifications of ASP: Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Oxygen activated sludge, Oxidation ponds, Stabilization ponds, Aerobic attached Growth Biological Treatment-Trickling Filter.	
	4.2	Design of ASP, Trickling Filter, Oxidation Pond, Oxidation Ditch and Aerated lagoons.	

5	**Anaerobic Decomposition:**		**08**
	5.1	Anaerobic Decomposition: Mechanism of anaerobic fermentation – a multistep process, Microbiology and Biochemistry of Anaerobic processes, Substrate inhibition, Stuck reactors, Standard rate, High rate and Multistage anoxic digesters. Introduction to UASB.	
	5.2	Design of anaerobic treatment units: Anaerobic Lagoons	
6	**Natural and Biotechnological Methods of Contamination Removal:**		**06**
	6.1	Natural Treatment Systems: Development of natural treatment systems, Rapid infiltration systems, Overland Flow systems, constructed wetlands, Floating aquatic plant treatment systems. Introduction to engineering Fundamentals of Biotechnology. Heavy Metal Removal using advance treatment methods – Membrane filtration, Reverse Osmosis and Ion exchange.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Determine and analyze the characteristics of wastewater and decide the treatment for wastewater.

2 Understand biological treatment process and necessity of contamination removal

3 Understand and apply the concepts of advancements/emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies.

4 Summarize the concept of aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems

5 Summarize the concept of the anaerobic decomposition and its application in wastewater treatment.

6 To derive the knowledge and develop rational approaches towards natural and biotechnological Methods for contamination removal

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.

2 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi.

3 Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.

4 Wastewater Treatment for Pollution Control and Reuse by Soli. J Arceivala (Author), Shyam. R Asolekar.

5 Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.

6 Water Supply and Sewerage: E.W. Steel.

7 Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.

8 Introduction to Environmental Engineering: P. Aarne Vesilind, Susan M. Morgan, Thompson.

9 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.

10 Basic Principles of Wastewater Treatment Book by Marcos Von Sperling.

Reference Books:

1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.

2 CPHEEO Manual on Sewage and Treatment.

3 Relevant Indian standard specifications and BIS publications.

4 Handbook of Water and Wastewater Treatment Plant Operations Book by Frank R. Spellman

Semester-VI

Course Code	Course Name	Credits
CEDLO6013	Department Level Optional Course-2 Construction Equipment & Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Machines have revolutionized every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods/techniques used to construct facilities using these equipments. It makes the student aware of the equipment/techniques required while constructing different kinds of civil engineering structures. Student will be introduced to some emerging technologies in the field of Civil engineering which will make them more industry ready.

Objectives

1 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.

2 To know the various conventional techniques/equipments used in civil engineering projects.

3 To get acquainted with the modern equipments/techniques which have replaced the conventional ones.

4 To select the appropriate equipment/techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources, etc.

5 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.

6 To know the various conventional techniques/equipments used in civil engineering projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction**		06
	1.1	Equipment v/s Labour, Standard and Special equipments, Types of costs related to equipments including related numerical, Equipment life and Replacement decisions including related numerical, Cycle time, Balancing of equipments and related numerical.	
	1.2	Different categories of construction equipments used conventionally with reference to available types and their output, working mechanism, factors affecting their performance and criteria for selecting a particular equipment: Earthmoving and other hauling equipment, Pavers for road construction. Numbering and Record maintaining of Earthmoving and other hauling equipment's; Pile driving equipment; Applications of Air compressor. Dewatering techniques for trenches; Stone crushing equipment.	
2	**Underground & Underwater Tunnelling**		09
	2.1	Various purposes for which tunnelling may be carried out, Basic terms related to tunnelling. Conventional methods of carrying out tunnelling in different types of soils/rocks. Methods for dewatering tunnels.	
	2.2	Detailed Procedure for underwater tunneling. Modern methods of tunnelling and detailed study of following equipments/ techniques in this regard. Use of drones, construction robots for aerial surveys. Use of GPS and remote sensing for setting out tunnel alignment. Jumbo – used for drilling and blasting, Blasting Techniques for quarrying stones for construction purpose. Diaphragm wall construction and other ground stabilization methods. Vertical shaft sinking machine (VSM). Tunnel Boring machine (TBM), Micro tunneling. New Austrian tunnelling method (NATM). Cut & cover method, Top to bottom construction. Tunnel lining trolley. Tunnelling for Metro projects. Difference in Tunnelling for Roads and Metros.	
3	**Modern Formwork Systems and Working Techniques in Limited Space**		06
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages. Modular shuttering, Slip and jump form.	
	3.2	High rise construction: Concrete making on mass scale, pumping and placing booms. Tower cranes and the benefits they offer for high rise construction. Range diagram.	

	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems. Emergency housing for disaster management.	
	3.4	Working skills/tricks required for managing a site in urban/restricted space environment. Techniques for controlled demolition of buildings.	
4	**Equipments For Laying of Utility Lines, Bridge Construction & Installation of Structural Steel Members.**		06
	4.1	Use of ground penetrating radar (GPR) for locating underground utilities. Laying of pipes using pipeline insertion system. Installation and operation of underground power transmission lines as well as overhead transmission towers.	
	4.2	Incremental launching method and balanced cantilever method of bridge/flyover construction with reference to the recent infrastructure developed in the local and global context.	
	4.3	Equipments/techniques used for connecting structural steel components of bridge decks, terminals, malls, stadiums, car sheds, etc.	
5	**Equipments/ Techniques for Setting Up of Power Generation/Supply Structures.**		06
	5.1	Hydropower station. Tidal power plants. Desalinization plants. Thermal power station. Solar power station. Atomic power generation. Installation and operation of wind mills. Construction of a fuel station.	
6	**Equipments/ Techniques for Construction of Transporting Facilities**		06
	6.1	Construction of railway lines using track laying machine. Methods, techniques and equipments involved in the construction of Metro, mono and maglev trains. Connecting link between underground and overhead metro systems. 5D BIM integration in Metro projects.	
	6.2	Equipments required for construction and operation of an airport and sea port. Application of Drones, GIS, GPS and BIM for monitoring project progress/working of Airports and Seaports. Piling Equipment's for Jetty Construction.	
	6.3	Light Detection and Ranging (Lidar) Technique for Railways/ Highways/ Bullet train alignments.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Understand the use/applications of various conventional construction equipments and select the best out of them for a particular site requirement.

2 Know modern methods/equipments used for underground as well as underwater tunnelling.

3 Compare conventional and modern methods of formwork and get acquainted with techniques used on sites with restricted space.

4 Understand the techniques involved and the equipments required thereof for laying of utility lines, bridge construction and installation of structural steel members.

5 Gain knowledge about the setting up of different kinds of the power generating structures.

6 Get acquainted with the equipments/ techniques for construction of transporting facilities.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Construction Equipment & Planning. Purifoy, R.L & Ledbetter McGraw Hill

2 Construction Equipment & its Management. Sharma, S. C. Khanna Publishers

3 Tunnel Engineering HandbookThomas R. Kuesel, Elwyn H. King, John O. Bickel Springer

4 Practical tunnel construction Gary B. Hemphill Wiley Publishers

5 Success with drones in Civil Engineering Brett Hoffstadt Kindle

6 Construction Technology for Tall BuildingsMichael Yit Lin Chew World Scientific

7 The prefabricated home Colin DaviesReaktion Books

8 Literature/specifications/downloadable videos available on Doka and Mivaan shuttering websites.

9 Accelerated Bridge Construction: Best Practices and Techniques Mohiuddin Ali Khan BH Elsevier

Reference Books:

1 Design and Construction of Nuclear Power Plants Rüdiger Meiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers
2 Energy and Power generation handbook K.R Rao ASME Press
3 Magnetic Levitation Hyung-Suk Han Dong-Sung Kim Springer
4 Metro Rail Projects in India M Ramachandran Oxford
5 BIM Handbook Eastman,Teicholz,Sacks,Liston John Wiley and Sons
6 IRC:43-2015 Recommended Practice for Plants, Tools and Equipment Required for Construction and Maintenance of Concrete Roads (First Revision).
7 IRC-2018 Pocket book for Road Construction Equipment.
8 IRC: SP-97- 2013 Guidelines on Compaction Equipment for Roads Works

Semester-VI

Course Code	Course Name	Credits
CEDLO6014	Department Level Optional Course -2 Urban Infrastructure Planning	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Indian cities are currently expanding at a rapid rate, and are therefore facing immense pressure for the improvement of their services and infrastructure. Without coordination and planning for the anticipated spatial growth and densification, the infrastructure services are neglected. Such growth areas can become under-serviced places of the cities, one from which many problems of the city stem: water, sanitation and waste problems, uncontrolled pests, and crime due to poor access to water and sanitation services. To address the emerging issues of urban centre, there is a pressing need to train urban infrastructure specialists who can comprehensively plan for city's growing infrastructure needs and formulate projects for efficient infrastructure service delivery for existing areas. There are ample urban infrastructure challenges and opportunities in terms of planning; effective policy, program and project formulation for well-trained young urban infrastructure professionals with specific domain knowledge

Objectives

1 Describe an infrastructure system using accurate terminology;
2 Demonstrate an understanding of the main concepts and principles of infrastructure planning;
3 Identify the key features of a sustainable infrastructure system and explain how they promote sustainable development;
4 Apply analytical tools for infrastructure planning;
5 Critically evaluate infrastructure cases/projects/proposals through the lens of sustainability;
6 Identify the gaps between theoretical principles of sustainable infrastructure and their application in practices

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Planning**		04
	1.1	Origins and growth of cities, effects of cultural influence on physical form; Human settlements as an expression of civilizations; Basic elements of the city; Concepts of space, time, scale of cities.	
	1.2	Contribution of housing to micro and macro economy, contribution to national wealth and GDP, housing taxation, national budgets, fiscal concessions; need of affordable housing for urban poor, concept of RERA	
2	**Urban Economics**		06
	2.1	General introduction to principles of economics and public finance. Importance of economics in Urban Development and Planning	
	2.2	Industrial location policies, any other economic activity base policies and their impact on urban development, Role of land economics in preparation of Urban Development plans. Relevant case studies of Urban Land Economics.	
	2.3	Economic growth and development, quality of life; Human development index, poverty and income distribution, employment and livelihood; Economic principles in land use planning; Policies and strategies in economic planning, balanced versus unbalanced growth, public sector dominance; changing economic policies, implications on land.	
3	**Infrastructure Planning**		12
	3.1	Role of Infrastructure in Development, Elements of Infrastructure (physical, social, utilities and services); Basic definitions, concepts, significance and importance; Data required for provision and planning of urban networks and services; Resource analysis, provision of infrastructure, and land requirements; Principles of resource distribution in space; Types, hierarchical distribution of facilities, Access to facilities, provision and location criteria, Norms and standards, etc.	
	3.2	Zoning, Various growth patterns of town, Housing layouts and road networks in town, Urban aesthetics and landscaping, MRTP and Land Acquisition Acts	
		Planning and Management of Water, Sanitation and Storm Water; Water – sources of water, treatment and storage, transportation and distribution, quality, networks, distribution losses; water harvesting, recycling and reuse, norms and standards of provision, institutional arrangements, planning	

		provisions and management issues; Sanitation – points of generation, collection, treatment, disposal, norms and standards, grey water disposal, institutional arrangements, planning provisions and management issues. Storm water – rainfall data interpretation, points of water stagnation, system of natural drains, surface topography and soil characteristics, ground water replenishment, storm water collection and disposal, norms and standards, institutional arrangements, planning provisions and management issues;	
	3.3	Solid Waste Disposal and Management Basic principles, generation, characteristics, collection, disposal, management	
	3.4	Fire and Electrification; and Social Infrastructure Planning for fire protection, services and space standards, location criteria; Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
	3.5	Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
4	**Traffic and Transportation Planning**		07
	4.1	Evaluation of urban structure: Transport system, infrastructure and management, transport systems and their types, design and operating characteristics, urban road hierarchy, planning, and management criteria for road and junction improvements, arterial improvement techniques.	
	4.2	Traffic management, mass transit system: Problems and prospects. Review of existing traffic management schemes in Indian cities. Case study of various metro rail project envisaged for Mumbai, Navi Mumbai & Pune.	
	4.3	Economic evaluation: pricing and funding of transport services and systems, economic appraisal of highway and transport projects. Techniques for estimating direct and indirect road user costs and benefit value of time	
	4.4	Intelligent transport system (ITS) its types and applications	
5	**Urban Management and Governance**		06
	5.1	Introduction to Development Management and Urban Governance- Concept, approaches, components, interface with national goals and political economic system. Urban Development Management Strategies, Tools and Techniques; organizations involved Land and Real Estate Development Economic concepts of land, Land Pricing / valuation; Urban reforms and acts and policies. Overview of Urban Governance Definition, concepts, components, government and governance, hierarchy and structure, forms of governance, process of inclusion and exclusion.	

	5.2	Information System and Urban Reforms Spatial and Non - spatial information systems; Use of GIS in overlaying infrastructure facilities, use of remote sensing in identifying and mapping urban structures.	
	5.3	Present organizations and involved in urban governance with focus on MCGM, TMC and CIDCO. Urban Local Governance and Participatory Processes System, structure, functions, powers, process and resource, performance, interface with NGO's, other agencies.	
6	**Environmentally Safe and Disaster Resilient Infrastructure**		04
	6.1	Frame work, statement prediction and assessment of impacts of air, water, noise, cultural and socio-economic environment. Methods of impact analysis, public participation. Environmental protection international and national agencies and legislation, Environment Impact Assessment. Urban Heat Island Effect, Effect of uncontrolled growth of town	
	6.2	Disaster response planning, roles and responsibilities of various agencies Emergency operation support and management Planning for Disaster Prone Areas, Planning requisites for disaster prone areas and preventive measures, Vulnerability analysis	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the concepts related to planning of modern cities, GDP contribution, RERA, affordable housing
2 Elaborate the economics involved in urban infrastructure planning
3 Envisage the various elements required for infrastructure development of a city and describe the concepts, significance and importance of each
4 Evaluate technical, social and economic feasibility of transportation projects within cities
5 Demonstrate modern tool usage for urban management and governance
6 Design environmentally safe and disaster resilient infrastructure

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 The Urban and Regional Planning Reader, edited by Eugenie L. Birch, Published by Routledge, 2008; ISBN 978-0-415-319
2 Housing: The Essential Foundations, edited by Dr. Paul Balchin, Paul Balchin, Maureen Rhoden, Edition Routledge, DOI https://doi.org/10.4324/9780203010426, eBook ISBN 9780203010426
3 New Urban Housing by Hilary French, Publisher: Yale University Press, ISBN0300115784 (ISBN13: 9780300115789)
4 Sociology: A Brief Introduction, by Richard T. Schaefer, Publisher: McGraw-Hill Education, ISBN 10:1259425584, ISBN 13: 9781259425585
5 Sociology: Principles of Sociology with an Introduction to Social Thoughts, by Rao C.N. Shankar, S. Chand Publication
6 Projects: Preparation, Appraisal, Budgeting and Implementation by Prasanna Chandra, Tata McGraw-Hill; ISBN0074516280 (ISBN13: 9780074516287)
7 Introduction to Transportation Planning, by B. Bruton, Michael J. Bruton; Published by Hutchinson Radius; ISBN0091580412 (ISBN13: 9780091580414)

Reference Books:

1 Modern Economics by H.L. Ahuja, 19th Revised Edition, Published by S.Chand (G/L) & Company Ltd
2 Economics, An Introductory Analysis by Paul A. Samuelson, William D. Nordhaus, Published July 27th 2004 by Irwin/McGraw-Hill (first published 1948), ISBN0072872055 (ISBN13: 9780072872057)
3 Modelling Transport, by de Dios Ortuzar and Luis G. Willumsen, 4th Edition, Wiley Publication
4 Principles of Urban Transport Systems Planning, by B.G. Hutchinson, Publisher: Scripta Book Co.; ISBN0070315396 (ISBN13: 9780070315396)
5 Traffic Engineering and Transport Planning, L. R. Kadiyali, Khanna Publishers, 1983
6 Remote Sensing and GIS, by Basudeb Bhatta, second Edition, Oxford University press
7 NEPA and Environmental Planning: Tools, Techniques, and Approaches for Practitioners; Charles H. Eccleston; CRC Press
8 Planning for Disaster: How Natural and Manmade Disasters Shape the Built Environment, by William Ramroth; Publisher: Kaplan Business; Original edition; ISBN-13: 978-1419593734.

Semester-VI

Course Code	Course Name	Credits
CEDLO6015	Department Level Optional Course -2 Open Channel Flow	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Civil engineers deal with the analysis and design of irrigation systems which include dams, weirs, barrages, canals, drains and other supporting systems, for which good knowledge of dynamics of open channel flow is very much essential. Hence this course is designed to study different types of flow like uniform flow, non- uniform flow, spatially varied flow, and unsteady flow occurring in open channels. Competencies developed by this course would therefore be useful for students to handle and solve the practical problems/ issues in the field of Water resource management, Water shed Management etc. It is expected that the students will be better equipped to address various engineering problems related to hydrology and hydraulics.

Objectives

1 Understand the nature of flow, explain the basic concepts of uniform flow and to design the best hydraulic sections in open channel.
2 Apply the Energy concepts of fluid in open channel and demonstrate various flow measurement devices in open channels.
3 Develop Dynamic equation to compute the flow profiles for Gradually varied flow and classify water profiles in prismatic channels with different slope conditions.
4 Illustrate the causes of Rapidly varied flow, predict the formation of hydraulic jump and its applications.
5 Determine different types of spatially varied flow with varying discharges and characteristics of water surface profiles.
6 Study and analyze the temporal flow variations in open channel and the formation of surges.

Detailed Syllabus

Module		Course Module / Contents	Periods
1	**Uniform Flow**		07
	1.1	Flow through open channel, Types of channels, open and covered channels, Classification of flow in channel, Geometrical properties, velocity distribution in a channel section	
	1.2	Uniform flow in open channels, Discharge through open channel, Manning's and Chezy's Equation, Determination of roughness coefficients,	
	1.3	Determination of Conveyance of a channel, Hydraulic mean depth, Normal depth and Normal velocity, computation of uniform flow	
	1.4	Most economical sections of prismatic channels, condition for maximum velocity in a circular channel, condition for maximum discharge in a circular channel	
2	**Energy-Depth Relationships**		07
	2.1	Specific energy, Specific energy curve, Depth- Discharge diagram, critical depth, critical slope, critical flow, alternate depths	
	2.2	Condition for maximum discharge for a given value of Specific energy	
	2.3	Momentum in open channel flow- Specific force, specific force diagram, Dimensionless specific force diagram,	
	2.4	Critical flow and its computation, Application of specific energy and discharge diagrams to channel transitions	
	2.5	Metering Flumes- Venturi flume, Standing wave flume, Parshall flume, Determination of mean velocity of flow, Measurement of discharge in Rivers	
3	**Non-Uniform Flow: Gradually Varied Flow**		07
	3.1	Dynamic equation of Gradually Varied Flow (GVF) in rectangular and wide rectangular channels	
	3.2	Types of slopes- channel bottom slopes and water surface slopes, classification of channel bottom slopes and surface profiles	
	3.3	Characteristics of surface profiles, Backwater curve and drawdown curve	
	3.4	Computation of GVF-Direct Step and Standard step method, Numerical methods, Graphical Integration method	

4	**Non-Uniform Flow: Rapidly Varied Flow**		**07**
	4.1	Rapidly varied flow (RVF), Hydraulic Jump, Momentum equation for the jump	
	4.2	Hydraulic jump in a rectangular channel, Froude Number before and after jump, Classification of jumps, Characteristics of jump in a rectangular channel	
	4.3	Jumps in non-rectangular channel, applications of jump, location of jump, surges in open channel	
	4.4	Use of RVF for flow measurement purpose-Sharp crested weir, Broad crested weir, Ogee spillway, sluice gate	
5	**Spatially Varied Flow**		**06**
	5.1	Importance of Spatially Varied Flow (SVF), Causes, Continuity, Momentum and Energy Equation	
	5.2	Water surface profiles, Applications, Differential Equation for SVF with increasing and decreasing discharge–	
	5.3	Relevant case studies	
6	**Unsteady Flow**		**05**
	6.1	Basic concepts of Gradually varied unsteady flow, Rapidly varied unsteady flow	
	6.2	Positive and negative surges	
	6.3	Relevant case studies	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Describe the basic nature of flow in open channels, analyze the behaviour of flow and apply basic theories to design the optimum channel sections.
2 Demonstrate the energy concepts in open channel and its practical applications.
3 Apply dynamic equation for Gradually varied flow (GVF) and evaluate water profiles at different conditions in prismatic channels.
4 Differentiate between GVF and Rapidly Varied Flow (RVF), analyze hydraulic jump in open channel and its importance.
5 Explain the spatially varied flow and classify water profiles.
6 Discuss the temporal variations of flow in GVF and RVF in open channel.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Flow in Open channels: K. Subramanya, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
2 Flow through Open channels: Rajesh Srivastava, Oxford University Press
3 Flow through Open channels: K. G. Ranga Raju, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
4 Fluid Mechanics and Hydraulics: Dr S.K. Ukarande, Ane's Books Pvt. Ltd., (Revised Version 2012)
5 Hydraulics & Fluid Mechanics: Modi P.N. & Seth S.M, Standard book house, New Delhi

Reference Books:

1 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York
2 Open Channel Flow: Henderson F.M., McGraw Hill International
3 Open Channel Flow: M. Hanif Chaudhry, Prentice Hall of India.
4 Open channel Hydraulics: French, R.H., McGraw Hill International

Semester-VI

Course Code	Course Name	Credits
CEDLO6016	Department Level Optional Course - 1 Computational Structural Analysis	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

This subject deals with the conceptual applications of principles of mechanics of rigid and deformable bodies in Structural Engineering.

Objectives

1 To understand basic concepts of Matrix Methods of Structural Analysis and application of approximation techniques (Numerical Methods) in analysis of Structural Member

2 To analyze the behavior of structural members viz beams/plane trusses/ continuous beams/ portal frames

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Basic concepts of structural analysis and methods of solving simultaneous equations**		04
	1.1	Introduction, Types of framed structures	
	1.2	Static and Kinematic Indeterminacy, Equilibrium equations	
	1.3	Compatibility conditions, principle of superposition, Energy principles, Equivalent joint loads	
	1.4	Methods of solving linear simultaneous equations- Gauss elimination method, Cholesky method and Gauss- Seidel method.	

2	**Fundamentals of Flexibility and Stiffness Methods**		**07**
	2.1	Concepts of stiffness and flexibility	
	2.2	Local and Global coordinates	
	2.3	Development of element flexibility and element stiffness matrices for truss, beam and grid elements	
	2.4	Force- transformation matrix	
	2.5	Development of global flexibility matrix for continuous beams, plane trusses and Rigid plane frames	
	2.6	Displacement- transformation matrix, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames.	
3	**Analysis Using Flexibility Method (Including Secondary Effects)**		**07**
	3.1	Continuous beams, plane trusses and rigid plane frames	
4	**Analysis Using Stiffness Method (Including Secondary Effects)**		**07**
	4.1	Continuous beams, plane trusses and rigid plane frames	
5	**Direct stiffness Method**		**07**
	5.1	Stiffness matrix for truss element in local and global coordinates	
	5.2	Analysis of plane trusses	
	5.3	Stiffness matrix for beam element	
	5.4	Analysis of continuous beams and orthogonal frames.	
6	**Finite Element Method**		**07**
	6.1	Historical Background – Mathematical Modeling of field problems in Engineering	
	6.2	Governing Equations – Discrete and continuous models	
	6.3	Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value	
	6.4	Basic concepts of the Finite Element Method.	
	6.5	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics.	
Total			**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Formulate force displacement relation by flexibility and stiffness method
2 Analyze the plane trusses, continuous beams and portal frames by transformation approach
3 Analyze the structures by direct stiffness method
4 Explain the basics of finite element formulation.
5 Apply finite element formulations to solve one dimensional Problems

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Matrix Methods of Structural Analysis, S. S Bhavikatti, WILEY
2 Matrix Analysis of Framed Structures, Weaver, W., and Gere, J.M., CBS Publishers and distributors pvt. Ltd., 2004.
3 Computational Structural Mechanics, Rajasekaran, S., and Sankarasubramanian, G., PHI, New Dehi, 2001.
4 Introductions to Matrix Methods of Structural Analysis, Martin, H, C., McGraw-Hill, New York, 1966.
5 Structural Analysis A Matrix Approach, G. S. Pandit, S. P. Gupta, TATA McGraw Hill
6 Matrix Computer Analysis of Structures, Rubinstein, M.F., Prentice-Hall

Reference Books:

1 Introductory Methods of Numerical Analysis, S S. Sastry, ASIN : 8120345924, Publisher-Prentice Hall India Learning Private Limited.
2 Introduction to the Finite Element Method, Desai Abel, CBS Publishers and distributors
3 Introduction to Finite Elements in Engineering, Chandrupatala, Belugundu, Pearson Education Publisher : Pearson; 4th edition (20 December 2011)
4 Numerical Methods for Engineers, Steven Chapra, Tata McGraw Hill

Semester-VI

Course Code	Course Name	Credits
CEDLO6017	Department Level Optional Course -2 Traffic Engineering and Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Traffic Engineering Management follows the Transportation Planning and is the specialized branch of the Highway Engineering, which introduces the concepts of characterizing traffic, various modeling approaches, and design of facilities to control and manage traffic. A key feature of the course is that it is well connected with the current design and analysis practice stipulated in national standards, and manuals. Therefore, it deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

1 To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one

2 The application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.

3 To understand the concept of various features of the intersection infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.

4 To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.

5 To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.

6 To explore the future of traffic engineering in the form of Intelligent Transportation system

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Traffic Characteristics and Surveys**		03
	1.1	Scope, Traffic Elements - Characteristics-vehicle, road user and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.	
2	**Application of Statistics in Traffic Engineering**		05
	2.1	Various probability distributions & their applications - Parameter estimation - Hypothesis testing - Random variables	
	2.2	Estimation and analysis of simple regression models - Correlation coefficients - Analysis of correlation coefficients	
	2.3	Application of queuing theory as applied to traffic flow problems for study state conditions	
3	**Intersection Design**		10
	3.1	Types of intersections - Conflict diagrams –Control hierarchy-Design of rotaries (Indo-HCM 2017) & at-grade intersections – Signal design as per IRC:93 - Grade separated intersections & their warrants, coordination of signals, types of area traffic control	
4	**Traffic Flow Theory**		10
	4.1	Measurement, microscopic and macroscopic Study of Traffic Stream Characteristic -Flow, Speed and Density; pace – Time diagram, Headways, Speeds, Gaps and Lags; gap acceptance. Fundamental Equation of Traffic Flow, Speed-Flow-Density Relationships, Shock Wave Theory Passenger's car units, Factors affecting PCU and methods to determine PCU, level of service, factor affecting capacity and level of service. Capacity and level of service suggested for different road facilities as discussed in Indo-HCM 2017, review of flow density speed studies, Light hill and Whitham's theory, fundamentals of traffic stimulation modeling.	
5	**Traffic Management and Road safety Audit**		07
	5.1	Various measures for traffic systems management and travel demand management-Congestion management -cost effective Management, their scope, relative merits and demerits. (Pedestrians and Cyclist Management) (IRC SP:55-2014)	
	5.2	Highway Lighting: Important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing, lantern arrangements, types of lamps, lighting of some important highway structures.	
	5.3	Accidents: Accident cause, recording system, analysis and	

		preventive measures, accident cost, alternative methodologies for calculation.	
	5.4	Road Safety Audit: Global & Local perspective – Road safety issues – Road safety programmers – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures, road safety audit process as per IRC: SP-88-2010	
6	**Intelligent Transportation System**		04
	6.1	Overview of ITS implementations in developed countries, ITS in developing countries. Study of IRC: SP-110-2017	
	6.2	Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects.	
	6.3	Application of ITS: Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1 Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
2 Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
3 Explain the concepts of PCU and LOS, their implication in determination of the capacity using Speed-Flow-Density relationships.
4 Discuss the aspects associated with road safety, its audit and different TSM measures.
5 Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
6 Improve the effectiveness and efficiency of transportation systems through advanced technologies in Information systems and communication.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.
2 Srinivasa Kumar .R ,Introduction to Traffic Engineering,The Orient Blackswan;south Asian Edition,2018.
3 Chakroborty P., Das N., Principles of Transportation Engineering, PHI,New Delhi,2003
4 Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee, 2001
5 Khisty C J,LallB.Kent; Transportation Engineering-An Introduction, Prentice-Hall,NJ, 2005
6 May, A.D., Traffic Flow Fundamentals, Prentice – Hall, Inc., New Jersey,1990.
7 O'Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK
8 Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York.
9 Benjamin J. R., Cornell C. A., Probability Statistics and Decision for Civil Engineers, McGraw-Hill, 1970.
10 Asad J. Khattak , Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press

Reference Books:

1 Transportation Engineering and Planning Papacostas, C. S., Prevedouros, P. D., PHIL earning Pvt. Ltd.
2 Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt.Ltd.
3 Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.;McGraw-Hill.
4 Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, NewYork.
5 Highway Capacity Manual, Transportation Research Board, National Research Council, WashingtonD.C.
6 Relevant IRC Codes amended time to time.

Semester-VI

Course Code	Course Name	Credits
CEDLO6018	Department Level Optional Course -2 Introduction to Offshore Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Offshore Engineering discipline deals with the design and construction of structures intended to work in the ocean environment. The majority of offshore structures are used in the Oil and Gas industry. Offshore construction is the installation of structures and facilities in a marine environment. Civil Engineering graduates will be able to work in the specialized field of ocean and coastal environment.

Objectives

1 To understand the complexities in offshore construction and obtaining resources from the ocean.

2 To addresses the general engineering concepts that are fundamental to offshore engineering.

3 To understand types of sites and platform structures, key engineering systems and ocean environmental monitoring

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction:**		05
	1.1	History and current state of the art of offshore structures, Definition of Offshore Structures, Met ocean Engineering: wind, wave and current loads on offshore structures	
2	**Environment & Construction:**		06
	2.1	Offshore environment, Construction and launching, offshore project management,	
3	**Ocean Construction:**		06

	3.1	Types of Platforms: Jackets, Tension Leg Platforms (TLP), Semisubmersibles, Jack-ups, Concrete Gravity, deep water construction in ocean, offshore site investigations	
4	**Offshore Pipelines:**		06
	4.1	Hydrostatic, hydrodynamic analysis and structural design	
5	**Buoys and Mooring systems:**		08
	5.1	Buoys and Mooring systems Mooring configurations, advantages and disadvantages	
6	**Design Criteria:**		08
	6.1	Introduction to probabilistic design, extreme load & strength & fatigue, basics of anchoring and mooring system, riser system, Scaling laws & Model testing, Challenges in Deepwater testing: deep-water installations, constructions challenges.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. To know various offshore construction methodologies
2. To addresses the general engineering concepts during construction stages.
3. To handle complexities and key engineering systems in ocean environment

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).
Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four questions need to be solved.

Recommended Books:

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume–I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 1GB, UK.
2. Deo M C (2013):Waves and Structures, http://www.civil.iitb.ac.in/~mcdeo/waves.html
3. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
4. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).

Semester-VI

Course Code	Course Name	Credits
CEL601	Design and Drawing of Steel Structures (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To estimate the design loads on steel structures as per IS 875

2 To analyze the member forces by any suitable method.

3 To design the members for axial, flexure and shear forces.

4 To prepare the detailed design report and fabrication drawings by manual or CAD software.

Course Outcomes:

At the end of the course, learner will be able to:

1 Calculate dead, live and wind loads on the structure.

2 Analyze the structure by analytical/graphical method.

3 Use steel table for selecting appropriate section.

4 Design the members for various load combinations.

5 Design the bolted and welded connection.

6 Read and Prepare the detailed fabrication drawing and design report.

The Project shall be given to a group of students consisting of not more than10 st lents.

List of the Projects

Schedule	Detailed Content	Lab S ssion / Hr.
Project 1	**Design and drawing of steel roof truss for industrial shed should c nsist of the following items.**	
1st Week	Introduction, problem statement, Calculation of panel point DL, LL, and WL on truss.	02
2nd Week	Analysis of truss by graphical method/ any software and calculation of design loads in members	02
3rd Week	Design of purlins, Principal rafter, Main Tie, Design of remaining members of truss. etc.	02
4th Week	Design of bolted /welded connections and design of sliding and hinged supports including anchor bolts	02
5th Week	To generate/draw fabrication drawings on full imperial size drawing sheet and design report on A4 size pages.	02
6th Week	To generate fabrication drawings and design report including estimation of steel required.	02
Project 2	**Design and drawing of floor beam system for steel building G+1 sl uld consist of the following items**	
7th Week	Introduction, problem statement and to draw grid floor plan.	02
8th Week	Calculation of DL, LL on slab, beams etc. and to analyze frame for BM and SF.	02
9th Week	Calculation of design loads on columns and footing.	02
10th Week	Design of beams, columns and footings.	02
11th Week	Design of beam end and beam-column connections.	02
12th Week	To generate/draw fabrication drawings on Full imperial size drawing sheet and design report on A4 size pages.	02
13th Week	To generate fabrication drawings and design report including estimation of steel required.	02

Assessment:

- **Term Work**

Shall consist of design report and fabrication drawings for the above projects and Site sit report related to this course. Distribution of marks for Term Work shall be as follows:

Project 1+Project 2+ Site visit report	:	20 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guideline shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral Examination will be based on Sketching Examination, Term Work and Entire syllabus

Recommended Books:

1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.

2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.

3 Design of steel structure by Limit State Method as per IS: 800 - 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.

4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.

5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.

6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi.

Reference Books:

1 Design of Steel Structure by Allen Williams

2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing

3 Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.

4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEL602	Water Resources Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To study different irrigation engineering methods and water requirement of crops.
2 To study hydrological cycle, its elements and plotting of hydrographs.
3 To study and calculate discharge from aquifers.
4 To study control level fixation for reservoir, Dams i.e gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.
5 To study importance of silt theories and its design considerations.
6 To study Canal headwork, its distribution system and design of canal structures.

Course Outcomes:

At the end of the course, learner will be able to:

1 Classify various techniques of water distribution and compute water requirement of crops.
2 Discuss in detail about hydrological process and interpret plotting of hydrographs.
3 Apply their knowledge on well hydraulics and compute discharge from an aquifer.
4 Classify and describe various hydraulic structures such as dams and carry out its analysis for structural stability.
5 Compare different silt theories related to irrigation channel and design the same.
6 Identify and classify different canal head works - its distribution system and canal structures.

List of Experiments (Minimum Five)		
Module	**Detailed Content**	**Lab Session / Hr.**
Assignment		
1	Assignment no 1: Irrigation projects in India and Numerical based Water requirement of crops.	02
2	Assignment no 2: Numerical based on missing data, hydrographs.	02
3	Assignment no 3: Numerical based on yield of aquifer.	02
4	Assignment no 4: Numerical based on stability of gravity dam, seepage line (earthen dam)	02
5	Assignment no 5: Numerical based on Silt Theories	02
6	Assignment no 6: Case study on different canals in India and abroad.	02
Model Preparation (if possible, prepare any one model from below suggested topic)		
1	Prepare a model for any one water distribution technique referring to introductory chapter.	06
2	Prepare model for Dam (Gravity or Earthen Dam).	

Assessment:

- **Term Work**

Comprises of Assignments which has to be submitted by each student individually and preparation of model can be worked out in group of 6 members each.

Distribution of marks for Term Work shall be as follows:

Assignments	:	20 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

1 Irrigation and Water Power Engineering: B.C. Punmia, PandeB.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
2 Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
3 Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4 Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5 Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
6 Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
7 Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
9 Design of Small Dams: USBR.
10 Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
11 Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester-VI

Course Code	Course Name	Credits
CEL603	Geotechnical Engineering-II Lab	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objective:

1 To study consolidation characteristics of soil.

2 To study and examine shear strength parameters of soil.

3 To Study and determine the strength of sub-grade soil.

4 To Study and determine swelling pressure of soil.

5 To gain the knowledge of stress distribution in soil.

6 To gain the knowledge of various geotechnical software.

Course Outcomes:

At the end of the course Students will be able to

1 Determine consolidation parameters such as coefficient of compressibility, coefficient of volume change, coefficient of consolidation.

2 Determine cohesion and angle of shearing resistance for various soil types.

3 Determine the CBR value of soil for pavement design.

4 Determine swelling pressure of soil.

5 Understand the concept of stress distribution in soils due to vertically applied load.

6 Solve design problems using geotechnical software.

List of Experiments (Minimum Five)		
Module	Detailed Content	Lab Session Hrs.
1	Determination of pre-consolidation pressure and coefficient of consolidation from one dimensional consolidation test	02

2	Determination of shear strength parameters using direct shear test	02
3	Determination of shear strength parameters using unconsolidated undrained tri-axial compression test	02
4	Determination of undrained cohesion using unconfined compression test	02
5	Determination of shear strength of soft clays by vane shear test	02
6	Determination of CBR value using CBR test	02
7	Determination of swelling pressure of clays	02

Assignment:

a) Term Work Assessment
Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on either vertical stress distribution in soils or a design problem using geotechnical engineering software. The teacher is expected to impart the knowledge to the students about the concept of stress distribution of soils or design problem using software. The questions related to stress distribution in soils or design problem using software shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Vertical stress distribution in soils: Estimation of vertical stress in soil due to surface load using Boussinesq equation.

OR

- Design problem using software: Introduction to any geotechnical software like Geo 5, PLAXIS, FLAC, MIDAS GTS-NX etc.

Distribution of Term Work Marks

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work : 15 Marks
Assignments : 05 Marks
Attendance : 05 Marks

- End Semester Oral Examination : 25 marks

Reference Books:

1 Engineering Soil Testing: Shamsher Prakash, P.K. Jain; Nem Chand & Bros
2 Soil Testing for Engineers: William T. Lambe; John Wiley and Sons, Inc.
3 Soil Mechanics Laboratory Manual: Brij Mohan DAS; Oxford University Press Inc.
4 Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri; John Wiley and Sons, Inc.
5 Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar; Laxmi Publications
6 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House
7 Soil Mechanics and Foundation Engineering: V. N.S. Murthy; Saitech Publications
8 Relevant Indian Standard Specifications Code: BIS Publications; New Delhi

Semester-VI

Course Code	Course Name	Credits
CEL604	Environmental Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To analyse engineering skill related to water and wastewater sample.

2 To apply decision related to treatment of water and wastewater based on standards.

3 To understand the fundamental characteristics of municipal solid waste.

4 To acquire knowledge on the severity of air pollution and suggest remedies and preventive measures.

5 To understand the basic concepts of noise and its measurement.

Course Outcomes:

At the end of the course, learner will be able to:

1 Impart the knowledge on quality or characteristic of water and wastewater sample.

2 Interpret the required treatment for water and wastewater based on standards and norms.

3 Impart the knowledge on quality of solid waste.

4 Measure the concentration of particulate matters, dust and dispersed pollutants in air.

5 Inspect the levels of noise and interpret the results.

List of Experiments (Any eight to be performed)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Determination of pH of water/ sewage sample /solid waste.	02
2	Determination of Turbidity in water sample.	02
3	Determination of Total Solids, suspended solids, dissolved solids, volatile solids.	02
4	Determination of chlorides.	02
5	Determination of Optimum dose of coagulant by using Jar Test.	02
6	Determination of Dissolved Oxygen.	02
7	Determination of Residual chlorine	02
8	Determination of air quality using High Volume air Sampler.	02
9	Determination of Level equivalent of Noise	02
10	Determination of Bio Chemical Oxygen Demand of sewage sample	02
11	Determination of Chemical Oxygen Demand of sewage sample.	02
12	Determination of moisture content of solid waste.	02

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral exam will be based on experiments performed, site visit and theory syllabus.

Reference Books:

1 Water Supply Engineering: S. K. Garg, Khanna Publication.
2 Environmental Engineering Vol II: Garg, S. K., Khanna Publishers New Delhi.
3 Water Supply Engineering: P.N. Modi, Rajsons Publication.
4 Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
6 CPHEEO Manual on Water Supply and Treatment.
7 CPHEEO Manual on Sewage and Treatment.

Semester-VI

Course Code	Course Name	Credits
CEL605	Skill Based Lab Course-III	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

1 To Provide hands on training on analysis, modelling and design of R. C. C. Framed structure and Steel structure.

2 To prepare the database and perform its statistical analysis using relevant software.

3 To understand and apply the basic functions of excel for data analysis, preparation of programs and generation of reports having mathematical and pictorial representation.

4 To design reliable and sustainable transportation systems.

5 To evaluate the demand of water for given population and create the proper distribution system.

6 To Apply the basic knowledge of various computer languages to create the programme pertaining to civil engineering domain.

Course Outcomes:

At the end of the course, learner will be able to:

1 To understand the functions involved various softwares related to civil engineering field.

2 To perform different functions of the software related to analysing modelling and designing the structure, creation of database and its analysis.

3 To describe and represent the data obtained from site, experimental work in various formats as per industrial requirements

4 To import road geometric design into the software as well as relate with the design standards applied into the software.

5 To design the effective distribution network system for the distribution of water resources.

6 To apply the knowledge to create the programme in excel and various computer languages for solving problems pertaining to civil engineering field.

List of Experiments (Minimum Eight)		
Module	**Detailed Content**	**Lab Session / Hr.**
Analysis, Modelling and Design of structure using professional software		**15**
1	Introduction to structural engineering software. Study of basic commands and tools.	03
2	Analysis of determinate and in-determinate structure. Extraction of shear force and bending moment diagram for given structure manually as well using software	03
3	Developing a model of simple plan of a building (square or rectangular)	03
4	Analysis of frames – R. C. C. framed structure	03
5	Analysis of frames – Steel structure	03
Preparation and analysis of database using open-source software		**03**
6	Introduction to statistical software – Basic function required for preparing database, statistical analysis of the data and its representation	03
Excel		**15**
7	Introduction to Excel – Basic function required for preparing database, statistical analysis of the data and its graphical representation a. Creation of database of result obtained from Traffic volume survey and its analysis b. Creating database of results obtained from laboratory experiments and its analysis	03
8	Preparation of programme using various functions in excel or any other relevant exercise in civil engineering field 1. Mix design of concrete 2. Design of pavement 3. Design of structural members	03
9	Preparation of checklist for various items of work in building construction for quality control, Preparation of various reports like Daily progress report, Daily Labour report, Weekly progress report, Weekly Labour report, Geotechnical reports, Audit reports	03
10	Use of transportation engineering related software for creation of contour, creation of cross section, setting horizontal and vertical alignment and calculation of cut and fill	03
11	Use of open-source software for designing and simulation of water distribution network	03
Programming using open-source software C or C++ or java or python		**06**
12	Introduction to programming software, Basics commands and tools for development of programme related to civil engineering field	03
13	Programming for Civil Engineers with content related to any domains of Civil Engineering problem solving using programming software.	03

Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 5 software generated reports/sheets/program outputs along with minimum 5 assignments or reports, distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks (comprising of min. 5 software generated sheets/program outputs)
Assignments	:	10 Marks (comprising of min. 5 Reports)
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Oral Examination

Oral exam will be based on Laboratory Work performed.

Reference Books:

1 Software manuals

2 IS 456, IS 800

3 Refereed Journal papers on Software applications

4 Manual on Water Supply and Treatment, C. P. H. E. E. O., Ministry of Urban Development, Government of India, New Delhi

5 The 'C' Programming Language, B.W Kernighan & D.M Ritchie, Prentice Hall of India

6 Statistics for Managers, Using Microsoft Excel, 8th Edition, David M., Levine, Pearson India Education service Pvt ltd.

Recommended Books:

1 Excel with Microsoft Excel: Comprehensive & Easy Guide to Learn Advanced MS Excel Paperback – 1 January 2019 by Naveen Mishra (Author); Publisher:Penman Books; Publication date: 1 January 2019; ISBN-10: 9389024153; ISBN-13: 978-9389024159

2 Structural Modeling, Analysis & Design Using Staad Pro Software Paperback – 15 October 2015 by Vignesh Kumar M (Author); Publisher: LAP Lambert Academic Publishing; Genre: Business & Economics; ISBN: 9783848447671, 9783848447671

3 Discovering Statistics Using SPSS for Windows: Advanced Techniques for the Beginner; By Andy P. Field; Publisher:Sage Publications; ISBN:9780761957553, 0761957553

4 Quality Management in Construction Projects; By Abdul Razzak Rumane; Copyright Year 2018; ISBN 9780367890032; Published December 10, 2019 by CRC Press

5 Introduction to Machine Learning with Python: A Guide for Data Scientists Paperback – 7 October 2016; by Andreas C. Mueller (Author), Sarah Guido (Author); ISBN-10: 1449369413; ISBN-13: 978-1449369415, 1st Edition; Publisher O 'Reilly

Semester-VI

Course Code	Course Name	Credits
CEM601	Mini Project -2B	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Rationale

Civil engineers deal with many challenges on daily basis. The civil engineering industry's growth has been need based and society centric. Computers and IT systems have touched almost every part of our lives and inter-disciplinary approach is way of life ahead. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their textbooks and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The solutions based on software, development of computer application, or IT systems based on artificial intelligence or IOT are expected from civil engineering students. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

1 To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.(BTL-2)
2 To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.(BTL-3)
3 To examine and break information into parts, by analyzing motives or causes.(BTL-4)
4 To learn evaluating information, validity of ideas and work based on a set of criteria. (BTL-5)
5 To create solutions by compiling information together in a novel way.(BTL-6)

6 To design software based model, application or IT system by combining elements in a new pattern or proposing new solutions. (BTL-6)

Course Outcomes:

At the end of the course, learner will be able to:

1 Identify problems based on societal /research needs and formulate a solution strategy.

2 Apply fundamentals to develop solutions to solve societal problems in a group.

3 Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.

4 Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.

5 Draw the proper inferences from available results through theoretical/experimental/simulations and assemble physical systems.

6 Create devises or design a computer program or develop computer application.

- **Guidelines for Mini Project -2B**

  Expected outcome is Software based, **"A Computerized Model/ A software/ A computer program, an IOT application or A Computer or Mobile based application "**.

  Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

  Students should find 'List of Mini project- 2B problems' in University web portal www.mu.ac.in, and in consultation with faculty supervisor/head of department/internal committee of faculties select the title.

  Students shall submit implementation plan in the form of Gant/PERT/CPM chart, which will cover weekly activity of mini project.

  A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

  Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

  Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

  Students shall convert the best solution into A Computerized Model/ a software/ A computer program, an IOT application or A Computer or Mobile based application using various components of their domain areas and demonstrate.

  The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

  With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it ispreferable that Students come out with original solution.

  However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2B:	
S501:	Development for Mobile App for Smart Traffic Management System Using Internet of Things
S502:	Development for Mobile App for IoT based smart traffic signal monitoring system using vehicle Count.
S503:	Development of (AI Based) software or mobile App. To identify quantity of (bricks, pipes, bars etc.) from photograph.
S504:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure from coin aimed photograph.
S505:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure.
S506:	Development of (AI Based) software or mobile App. For Assessment of Irrigation Water Quality Index.
S507:	Development of (AI Based) software or mobile App. For Ground Water Quality monitoring in industrial zone.
S508:	Development of (AI Based) software or mobile App Advanced Earthquake Resistant Techniques
S509:	Development of Remote Monitoring System For Civil Engineering projects.
S510:	Application of Geographic Information system using Quantum GIS software.
S511:	Development of (AI Based) software or mobile App for Building Information Modelling using ArchiCAD/ Revit architecture software.
S512:	Development of (AI Based) software or mobile App Digitization of Slump cone Test.
S513:	Development of (AI Based) software or mobile App Digitization of other mechanical Tests.
S514:	Development of (AI Based) software or mobile App Civil Engineering quantity calculator.
S515:	Development of (AI Based) software or mobile App Digitization of Non-destructive testing of concrete-various methods.
S516:	Development of (AI Based) software or mobile App Mapping of area using Total Station and plotting the same on 3-d drafting.
S517:	Preparation of Excel VBA sheet for solving Survey, Soil Mechanics, Structural Analysis problems.
S518:	Development of (AI Based) software or mobile App Smart street lights and fault location monitoring in the cloud over IoT
S519:	Development of (AI Based) software or mobile App IOT based smart irrigation system
S520:	Development of (AI Based) software or mobile App Smart cities: Traffic data monitoring over IoT for easy transportation/alternative route selection
S521:	Development of (AI Based) software or mobile App Dam gate level monitoring for water resource analysis and dam gate control over IoT.
S522:	Development of (AI Based) software or mobile App Smart colony: RFID based gate security system, street lights, and water pump automation.
S523:	Development of (AI Based) software or mobile App Agriculture automation using GSM (soil moisture level control and motor control)

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

- **Term Work**

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book : 10 Marks
Marks awarded by review committee : 10 Marks
Quality of Project report : 5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **Assessment criteria of Mini Project:**

Mini Project shall be assessed based on following criteria:

Quality of survey/ need identification
Clarity of Problem definition based on need.
Innovativeness in solutions
Feasibility of proposed problem solutions and selection of best solution
Cost effectiveness
Societal impact
Innovativeness
Cost effectiveness and Societal impact
Full functioning of working model as per stated requirements
Effective use of skill sets
Effective use of standard engineering norms
Contribution of an individuals as member or leader
Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

  Report should be prepared as per the guidelines issued by the University of Mumbai.

  Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.
  Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

- **Mini Project shall be assessed based on following points:**

  Quality of problem and Clarity

  Innovativeness in solutions

  Cost effectiveness and Societal impact

  Full functioning of working model as per stated requirements

  Effective use of skill sets

  Effective use of standard engineering norms

  Contribution of an individuals as member or leader

  Clarity in written and oral communication

R19- BE

University of Mumbai

No. AAMS_UGS/ICC/2022-23/109

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/44 of 2019-20 dated 9th July, 2019 relating to the revised syllabus of B.E (Civil Engineering) (Sem. – VII & VIII) (CBCGS).

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 06th June, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.16 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.16 (R) and that in accordance therewith, the revised syllabus of B.E. (Civil Engineering) (Sem. – VII & VIII) (CBCS) Final Year (Rev-2019 'C' Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.16(R)/11/07/2022

* * *

No. AAMS_UGS/ICC/ 2022-23/ 109 20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publications Section),
7. The Deputy Registrar (Special Cell),
8. The Deputy Registrar, Fort/Vidyanagari Administration Department (FAD) (VAD), Record Section,
10. The Professor-cum- Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A. to Hon'ble Vice-Chancellor,
2. P.A. to Pro-Vice-Chancellor,
3. P.A. to Registrar,
4. All Deans of all Faculties,
5. P.A. to Finance & Account Officer, (F. &. A.O.),
6. P.A. to Director, Board of Examination & Evaluation,
7. P.A. to Director, Innovation, Incubation and Linkages,
8. P.A. to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. Of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Welfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA,

for information.

AC – 11 July, 2022
Item No. – 6.16 (R)

University of Mumbai

Revised Syllabus for

B.E. (Civil Engineering)

(Sem. - VII and VIII)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: ______________ **Title of Course**	B.E. (Civil Engineering)
O: ______________ Eligibility	After Passing Third Year Engineering as per the Ordinance 6244
R: ______________ **Passing Marks**	40%
No. of years/Semesters:	4 years / 8 semesters
Level:	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	New / Revised 2019
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Dr. Suresh K. Ukarande
Chairman,
Board of Studies in Civil Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology University of Mumbai

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Final Year of Engineering from the Academic year 2022-23.

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 "C" scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering

fundamentals

2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-graduate studies
4. To motivate learners for life-long learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering **University of Mumbai**			
Dr. S. K. Ukarande	Chairman	Dr. V. Jothiprakash	Member
Dr. D.D. Sarode	Member	Dr. K. K. Sangle	Member
Dr. S. B. Charhate	Member	Dr. D. G. Regulawar	Member
Dr. Milind Waikar	Member	Dr. A. R. Kambekar	Member
Dr. R.B. Magar	Member	Dr. Seema Jagtap	Member

Semester – III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics – III	03	-	01	03	-	01	04
CEC302	Mechanics of Solids	04	-	-	04	-	-	04
CEC303	Engineering Geology	03	-	-	03	-	-	03
CEC304	Architectural Planning & Design of Buildings	02	-	-	02	-	-	02
CEC305	Fluid Mechanics – I	03	-	-	03	-	-	03
CEL301	Mechanics of Solids	-	02	-	-	01	-	01
CEL302	Engineering Geology	-	02	-	-	01	-	01
CEL303	Architectural Planning & Design of Buildings	-	02	-	-	01	-	01
CEL304	Fluid Mechanics – I	-	02	-	-	01	-	01
CEL305	Skill Based Lab Course – I	-	03	-	-	1.5	-	1.5
CEM301	Mini Project – 1A	-	$03^{\$}$	-	-	1.5	-	1.5
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC301	Engineering Mathematics –III	20	20	20	80	03	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	03	-	-	100
CEC303	Engineering Geology	20	20	20	80	03	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	03	-	-	100
CEC305	Fluid Mechanics – I	20	20	20	80	03	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics – I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course – I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1A	-	-	-	-	-	50	-	50
Total		**100**			**400**	**-**	**225**	**100**	**825**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Second year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2020-2021**)
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics – IV	03	-	01	03	-	01	04
CEC402	Structural Analysis	04	-	-	04	-	-	04
CEC403	Surveying	03	-	-	03	-	-	03
CEC404	Building Materials & Concrete Technology	03	-	-	03	-	-	03
CEC405	Fluid Mechanics-II	03	-	-	03	-	-	03
CEL401	Structural Analysis	-	02	-	-	01	-	01
CEL402	Surveying	-	03	-	-	1.5	-	1.5
CEL403	Building Material Concrete Technology	-	02	-	-	01	-	01
CEL404	Fluid Mechanics-II	-	02	-	-	01	-	01
CEL405	Skill Based lab Course – II	-	02	-	-	01	-	01
CEM401	Mini Project – 1B	-	$03^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	**01**	**16**	**07**	**01**	**24**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125
CEC402	Structural Analysis	20	20	20	80	03	-	-	100
CEC403	Surveying	20	20	20	80	03	-	-	100
CEC404	Building Materials & Concrete Technology	20	20	20	80	03	-	-	100
CEC405	Fluid Mechanics-II	20	20	20	80	03	-	-	100
CEL401	Structural Analysis	-	-	-	-	-	25	25	50
CEL402	Surveying	-	-	-	-	-	50	25	75
CEL403	Building Material Concrete Technology	-	-	-	-	-	25	25	50
CEL404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL405	Skill Based lab Course - II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1B	-	-	-	-	-	25	25	50
Total		**100**			**400**	-	**225**	**125**	**850**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC501	Theory of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC502	Applied Hydraulics	03	-	-	03	-	-	03
CEC503	Geotechnical Engineering-I	03	-	-	03	-	-	03
CEC504	Transportation Engineering	04	-	-	04	-	-	04
CEDLO501X	Department Level Optional Course-1	03	-	-	03	-	-	03
CEL501	Theory of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL502	Applied Hydraulics	-	02	-	-	01	-	01
CEL503	Geotechnical Engineering-I	-	02	-	-	01	-	01
CEL504	Transportation Engineering	-	02	-	-	01	-	01
CEL505	Professional Communication and Ethics	-	02^{*}+2	-	-	02	-	02
CEM501	Mini Project – 2A	-	$04^{\$}$	-	-	02	-	02
Total		**16**	**16**	**-**	**16**	**08**	**-**	**24**

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC501	Theory of Reinforced Concrete Structures	20	20	20	80	03	-	-	100
CEC502	Applied Hydraulics	20	20	20	80	03	-	-	100
CEC503	Geotechnical Engineering-I	20	20	20	80	03	-	-	100
CEC504	Transportation Engineering	20	20	20	80	03	-	-	100
CEDLO501X	Department Level Optional Course -1	20	20	20	80	03	-	-	100
CEL501	Theory of Reinforced Concrete Structures	-	-	-	-	-	25	25	50
CEL502	Applied Hydraulics	-	-	-	-	-	25	25	50
CEL503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Professional Communication and Ethics	-	-	-	-	-	25	25	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
Total		**100**			**400**	-	**150**	**150**	**800**

*** Theory class to be conducted for full class**

$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai

(With Effect from A.Y. **2021-2022**)
Semester - V

Department Level Optional Course – 1

Sr. No.	**Course Code CEDLO501X**	**Department Level Optional Course – 1**
1	CEDLO5011	Modern Surveying Instruments and Techniques
2	CEDLO5012	Building Services & Repairs
3	CEDLO5013	Sustainable Building Materials
4	CEDLO5014	Advanced Structural Mechanics
5	CEDLO5015	Air and Noise Pollution & Control
6	CEDLO5016	Transportation Planning & Economics
7	CEDLO5017	Advanced Concrete Technology

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai

(With Effect from A.Y. **2021-2022**)
Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC601	Design & Drawing of Steel Structures	03	-	-	03	-	-	03
CEC602	Water Resources Engineering	03	-	-	03	-	-	03
CEC603	Geotechnical Engineering-II	03	-	-	03	-	-	03
CEC604	Environmental Engineering	04	-	-	04	-	-	04
CEDLO601X	Department Level Optional Course -2	03	-	-	03	-	-	03
CEL601	Design & Drawing of Steel Structures	-	02	-	-	01	-	01
CEL602	Water Resources Engineering	-	02	-	-	01	-	01
CEL603	Geotechnical Engineering-II	-	02	-	-	01	-	01
CEL604	Environmental Engineering	-	02	-	-	01	-	01
CEL605	Skill Based Lab Course – III	-	03	-	-	1.5	-	1.5
CEM601	Mini Project – 2B	-	$03^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	-	**16**	**07**	-	**23**

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test – I	Test - II	Avg.					
CEC601	Design & Drawing of Steel Structures	20	20	20	80	04	-	-	100
CEC602	Water Resources Engineering	20	20	20	80	03	-	-	100
CEC603	Geotechnical Engineering-II	20	20	20	80	03	-	-	100
CEC604	Environmental Engineering	20	20	20	80	03	-	-	100
CEDLO601X	Department Level Optional Course -2	20	20	20	80	03	-	-	100
CEL601	Design & Drawing of Steel Structures	-	-	-	-	-	25	25	50
CEL602	Water Resources Engineering	-	-	-	-	-	25	25	50
CEL603	Geotechnical Engineering-II	-	-	-	-	-	25	25	50
CEL604	Environmental Engineering	-	-	-	-	-	25	25	50
CEL605	Skill Based Lab Course-III	-	-	-	-	-	25	25	50
CEM601	Mini Project – 2B	-	-	-	-	-	25	25	50
Total		**100**			**400**	-	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini Project

$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester - VI

Department Level Optional Course – 2

Sr. No.	Course Code CEDLO601X	Department Level Optional Course – 2
1	CEDLO6011	Rock Mechanics
2	CEDLO6012	Biological Processes & Contaminant Removal
3	CEDLO6013	Construction Equipment & Techniques
4	CEDLO6014	Urban Infrastructure Planning
5	CEDLO6015	Open Channel Flow
6	CEDLO6016	Computational Structural Analysis
7	CEDLO6017	Traffic Engineering and Management
8	CEDLO6018	Introduction to Offshore Engineering

Undergraduate Program Structure for Final year Civil Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC701	Design & Drawing of Reinforced Concrete Structures	03	-	-	03	-	-	03

CEC702	Quantity Survey, Estimation and Valuation	03	-	-	03	-	-	03
CEDLO701X	Department Level Optional Course – 3	03	-	-	03	-	-	03
CEDLO702X	Department Level Optional Course – 4	03	-	-	03	-	-	03
CEILO701X	Institute Level Optional Course – I	03	-	-	03	-	-	03
CEL701	Design & Drawing of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL702	Quantity Survey, Estimation and Valuation	-	02	-	-	01	-	01
CEP701	Major Project-Part I	-	06*	-	-	03	-	03
Total		**15**	**10**	**-**	**15**	**05**	**-**	**20**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701 X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702 X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701 X	Institute Level Optional Course – I	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project-Part I	-	-	-	-	-	25	25	50
Total		**100**			**400**	**-**	**75**	**75**	**650**

*** Faculty load- In Semester VII - 1/2 hour per week per project group**

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. **2022-2023**)

Semester - VII

Department Level Optional Course – 3

Sr. No.	Course Code CEDLO701X	Department Level Optional Course – 3
1	CEDLO7011	Pre-stressed Concrete
2	CEDLO7012	Applied Hydrology and Flood Control
3	CEDLO7013	Appraisal and Implementation of Infra Projects

4	CEDLO7014	Analysis of Offshore Structures
5	CEDLO7015	Advanced Construction Technology
6	CEDLO7016	Pavement Materials Construction and Maintenance

Department Level Optional Course – 4

Sr. No.	Course Code CEDLO702X	Department Level Optional Course – 4
1	CEDLO7021	Foundation Analysis and Design
2	CEDLO7022	Solid and Hazardous Waste Management
3	CEDLO7023	Ground Improvement techniques
4	CEDLO7024	Green building constructions
5	CEDLO7025	Legal Aspects in constructions
6	CEDLO7026	Environmental impact assessment
7	CEDLO7027	Advanced Design of Steel Structures

Institute Level Optional Course – I

Sr. No.	Course Code CEILO701X	Institute Level Optional Course – I
1	ILO7011	Product Life-cycle Management
2	ILO7012	Reliability Engineering
3	ILO7013	Management Information Systems
4	ILO7014	Design of Experiments
5	ILO7015	Operations Research
6	ILO7016	Cyber Security and Laws
7	ILO7017	Disaster Management and Mitigation Measures
8	ILO7018	Energy Audit and Management
9	ILO7019	Development Engineering

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai

(With Effect from A.Y. **2022-2023**)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC801	Construction Management	03	-	-	03	-	-	03
CEDLO801X	Department Level Optional Course – 5	03	-	-	03	-	-	03
CEDLO802X	Department Level Optional Course – 6	03	-	-	03	-	-	03
CEILO801X	Institute Level Optional	03	-	-	03	-	-	03

	Course – II							
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – Part II	-	$12^{\$}$	-	-	06	-	06
Total		**12**	**14**	-	**12**	**07**	-	**19**

Examination Scheme									
Course Code	**Course Name**	**Internal Assessment**			**End Sem Exam**	**Exam Duration (Hrs.)**	**Term Work**	**Pract. /Oral**	**Total**
		Test - I	**Test – II**	**Avg.**					
CEC801	Construction Management	20	20	20	80	03	-	-	100
CEDLO801X	Department Level Optional Course – 5	20	20	20	80	03	-	-	100
CEDLO802X	Department Level Optional Course – 6	20	20	20	80	03	-	-	100
CEILO801X	Institute Level Optional Course – II	20	20	20	80	03	-	-	100
CEL801	Construction Management	-	-	-	-	-	25	25	50
CEP801	Major Project – Part II	-	-	-	-	-	50	100	150
Total		**80**			**320**	-	**75**	**125**	**600**

$: Faculty load- In Semester VIII - 1 hour per week per project group

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2022-2023)
Semester VIII
Department Level Optional Course – 5

Sr. No.	Course Code CEDLO801X	Department Level Optional Course – 5
1	CEDLO8011	Bridge Engineering
2	CEDLO8012	Design of Hydraulic Structures
4	CEDLO8013	Construction Safety
5	CEDLO8014	Pavement Design
6	CEDLO8015	Industrial Waste Treatment
7	CEDLO8016	Soil Dynamics

Department Level Optional Course – 6

Sr. No.	Course Code CEDLO802X	Department Level Optional Course – 6
1	CEDLO8021	Repairs, Rehabilitation and Retrofitting of structures
2	CEDLO8022	Physico-Chemical Treatment of Water and Waste Water
3	CEDLO8023	Transportation System Engineering
4	CEDLO8024	Smart Building Materials
5	CEDLO8025	Structural Dynamics
6	CEDLO8026	Ground Water Engineering

Institute Level Optional Course – II

Sr. No.	Course Code CEILO801X	Institute Level Optional Course – II
1	ILO8011	Project Management
2	ILO8012	Finance Management
3	ILO8013	Entrepreneurship Development and Management
4	ILO8014	Human Resources Management
5	ILO8015	Professional Ethics and Corporate Social Responsibility (CSR)
6	ILO8016	Research Methodology
7	ILO8017	Intellectual Property Rights and Patenting
8	ILO8018	Digital Business Management
9	ILO8019	Environmental Management

Faculty may design and conduct practicals for elective subjects wherever possible, under the head ‘content beyond syllabus’.

Semester VII

Semester VII

Course Code	Course Name	Credits
CEC701	Design and Drawing of Reinforced Concrete Structures	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	04 Hrs.	--	--	--	100

Rationale

Reinforced concrete construction is widely used for residential, commercial and industrial structures. IS code has specified the use of Limit State Method (LSM) design philosophy for design of structures. During previous semester students have studied design of basic elements by LSM. This course covers complete design of G+3 RCC framed building in addition to other structures like water tank and retaining wall. Pre-stressed Concrete structures are another class of structures used for bridge girders, long span slabs etc. Civil Engineers must have knowledge of designing and detailing of RCC and PSC structures to make structures safe and serviceable during its life span. The knowledge about response of structures during an earthquake is prerequisite for Civil Engineers. The course introduces Prestressed concrete and Earthquake Resistant Design of structures with drawing and detailing as per IS Code specifications.

Objectives

1. To explain the LSM design procedure of G+3 RCC framed building by application of IS code clauses including loading calculations, analysis and design of individual elements with detailing of reinforcements.
2. To explain the concepts in the design of water tanks.
3. To explain the concepts in the design of retaining walls.
4. To introduce the basics of structural dynamics, structural behavior under the dynamic load and the effect of damping.
5. To introduce earthquake resistant design approach.
6. To develop the practice of design using charts and tables from SP:16 published by BIS.
7. To introduce concept of Pre-stressed Concrete.

Detailed Syllabus

Module	Contents		Periods
I	**Comprehensive Design of Building**		11
	1.1	Analysis and design of residential/commercial/industrial (G+ 3) RCC framed building.	
	1.2	Load transfer mechanism, arrangement of beams, slabs and columns.	
	1.3	Design of Staircase (Dog legged and Open well type), Slabs (One way and Two way with continuity), Beams (Simply supported, Cantilever, Continuous), Columns (Axially loaded and Eccentrically loaded), Footings (Isolated and Combined).	
II	**Design of Retaining Wall**		06
	2.1	Design of Cantilever retaining wall	
	2.2	Design of Counterfort retaining wall	
III	**Design of Water Tank**		07
	3.1	Classification of Water Tank, Permissible Stresses, and Design of circular and rectangular water tanks resting on ground and underground. Codal provisions as per IS 3370:2020. Use of IS coefficient method and approximate method.	
	3.2	Introduction to design of elevated water tank, frame and shaft type of staging.	
IV	**Introduction to Structural Dynamics**		06
	4.1	Definition of basic terms used in structural dynamics. Static and dynamic loads, types of dynamic load.	
	4.2	Introduction to single degree of freedom system (SDOF), evaluation of dynamics response of SDOF system. Approximate method for determination of time period of vibration.	
V	**Earthquake Resistant Design of Structures**		06
	5.1	Earthquake motion and response of structure.	
	5.2	Design load calculation by seismic coefficient method.	
	5.3	Ductile design and detailing as per IS: 13920.	
VI	**Introduction to Pre-stressed Concrete**		03
	6.1	Prestressed Concrete: basic principles of prestressed concrete, materials used, systems of prestressing.	
	6.2	Losses in prestress.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Design G+3 RCC framed building using IS code recommendations.
2. Design different types of retaining walls with detailing of reinforcement
3. Design different types of water tanks with detailing of reinforcement.
4. Apply the basic concepts of structural dynamics

5. Evaluate the response of structure during an earthquake and calculate design forces.
6. Explain principles of Pre-stressed Concrete and its losses.

Internal Assessment 20 Marks

Consisting of two class tests - first test based on approximately 40% of content and second test based on remaining content (approximately 40% but excluding content covered in first test). Average of marks will be considered for IA.

End Semester Examination 80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. **Use of relevant IS codes shall be allowed in the examination.**
2. Question paper will comprise of total six questions, each carrying 20 marks.
3. Question 1 will be compulsory based on entire syllabus.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Four questions need to be solved in total.

Recommended Books:

1. Design of Reinforced Concrete Structures: *Dayaratnam, P;* Oxford and IBH.
2. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand & bro.
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House, New Delhi
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.
10. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel, Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.

4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. Pre-stressed concrete: N. Rajgopalan, Narosa Publishers.
7. Relevant IS Codes: BIS Publications, New Delhi.

Semester VII		
Course Code	**Course Name**	**Credits**
CEC702	**Quantity Survey, Estimation & Valuation**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	04 Hrs.	--	--	--	100

Rationale

Any structure, i.e., building, bridge, dam etc. consists of various building materials. Due to rise in the cost of materials, the structure has to be designed so that it is safe, serviceable and economical. Without proper design and estimation, it may lead to the increase in cost of construction and it further affects the economical aspect of the structure. A prior knowledge ofvarious building materials is required for the construction and it controls the cost of the structure, save wastage of labor-hours and eventually helps in giving the correct amount required and quantity of various materials required. It also helps in scheduling of men, materialsand machine to be used in the project at stages. The scope of the subject includes estimating, costing, analysis of rates, specification, valuation, tender and contracts etc.

Objectives

1. To emphasize the importance of relevant IS: 1200 - 1964 codes and understand Measurement systems for various items of civil engineering structures
2. To draft the specifications for various items of work & determine unit rates of items of works & to prepare the rate analysis for various items of work using DSR for reference.
3. To study the various methods of detailed and approximate estimates.
4. To calculate the quantity of earthwork using various methods.
5. To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.
6. To explain the concept of valuation & to determine the present fair value of any constructed building at stated time.

Detailed Syllabus

Module	Sub-Modules/ Contents		Hrs.
I.	**Introduction**		03
	1.1	Importance of Course	
	1.2	Measurement systems for specific items of civil engineering structures	
	1.3	Units of measurement of various items of works	
	1.4	IS1200: - Introduction, deduction rules for Masonry & Plastering work	
II.	**Specifications & Rate Analysis**		06
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of important items of work etc.	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labor output, District Schedule of Rates (DSR) Rate analysis of important items of construction works.	
	Estimates		

III.	3.1	**Approximate Estimate** Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, technical sanction, Contingencies, Work charged establishments etc.	**12**
	3.2	**Detailed Estimate** Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Introduction of detailed estimate of load bearing structure. Methods of taking out quantities such as long wall & short wall method, Centre line method for R.C.C. framed structure, Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structuralelements as per code IS2502.	
IV.	**Estimation of Earthwork for Roads & Canals**		**04**
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula etc. & numerical based on methods. Introduction of Mass Haul diagram, Terms like lead & lift etc.	
V.	**Tenders & Contracts**		**06**
	5.1	**Tenders** Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	**Contracts** Definition, basic forms such as Valid, void & voidable contract. General types of contracts with their suitability, conditions of contract	

VI.	**Valuation**		08
	6.1	Difference between cost, price & value. Types of value, Valuation & its purposes. Various terms such as depreciation, sinking fund, capitalized value, years purchase etc. Methods for calculating depreciation of building such as Straight-line method, Sinking fund method Freehold Properties, Leasehold Properties, Easement rights	
	6.2	Methods of valuation such as Rental method, land & building method, Belting method etc. Numerical based on valuation	

Contribution to Outcomes

On completion of the course, the learners will be able to:

1. **Apply** the measurement systems to various civil engineering items of work.
2. **Draft** the specifications for various items of work & determine unit rates of items of works
3. **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures, including bar bending schedule, by referring drawings.
4. **Assess** the quantities of earthwork & **construct** mass haul diagrams.
5. **Draft** tender notice & **demonstrate** the significance of the tender as well as contract process.
6. **Determine** the present fair value of any constructed building at stated time.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests – First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test). Average of marks will be considered for IA.

End Semester Examination: **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1) Question paper will comprise of **six** questions; each carrying 20 marks.
2) The **first** question will be **compulsory** based on computation of quantities of various items of work by referring drawings.
3) The remaining **five** questions will be based on all the modules of entire syllabus. For this,the modules shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
4) The students will have to attempt any **three** questions out of remaining five questions. Total **four** questions need to be attempted.

5) There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics / sub-topics.

Recommended Books:

1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.*, Kolkata.
2) Building and Engineering Contracts: *Patil, B. S.*, University Press, Hyderabad.
3) Estimating and costing: *Datta, B. N.*, UBS Publications
4) Relevant Indian Standard Specifications, BIS Publications
5) Professional Practice: Dr. Roshan H. Namavati
6) World Bank approved contract documents

Semester VII

Course Code	Course Name	Credits
CEDLO7011	Department Level Optional Course-3: Pre-stressed Concrete	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs	--	--	--	100

Rationale

The course is aimed to make the learners aware about highly mechanized technology in civil engineering construction and to develop the basic understanding of prestressed concrete which is used in a wide range of civil structures like high rise buildings, residential slabs and bridges etc. Prestressed Concrete improves performance/efficiency of the section. It reduces cross sectional dimensions that results in material saving when compared with simple reinforced concrete sections.

Objectives

1 To make the learner to understand difference between PSC and RCC section in terms of material and method / technique used for construction.

2 To make the learner to understand the principle of prestressing, analysis of prestressed concrete sections and losses in prestress.

3 To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction of Pre-stressed Concrete**		02
	1.1	Basic concept and general principle	
	1.2	Materials used and their properties, need of high strength concrete and steel	
	1.3	Techniques and systems of prestressing	
	1.4	Advantages of Prestressed Concrete	
II	**Analysis of Pre-stressed Concrete Beams**		10
	2.1	Loading stages, permissible stresses in concrete in compression and tension at transfer and service stages as per limit state of serviceability, maximum compression and limit state of serviceability cracking, permissible stresses in steel, stress method of analysis	

	2.2	Load balancing method of analysis, cable profile	
	2.3	Kern points, pressure line, efficiency of section, internal resisting couple method of analysis,	
III	**Losses in Prestress**		06
	3.1	Loss of stresses in steel due to elastic deformation of concrete, creep in concrete, shrinkage in concrete, relaxation in steel, anchorage slip and friction	
IV	**Analysis of Pre-stressed Concrete Beams in Limit State of Serviceability Deflection**		04
	4.1	Deflection at transfer, short time and longtime deflection of uncracked beams, permissible limits	
V	**Analysis and Design of Pre-stressed Concrete Beams in Limit State of Collapse**		10
	5.1	Shear - Principal tension, permissible limit, analysis and design of beams in shear (sections uncracked in flexure)	
	5.2	Flexure - General philosophy of design, assumptions, analysis and design of beams in flexure	
VI	**Design of Pre-stressed Concrete Beams in Limit State of Serviceability, Maximum Compression and Cracking**		07
	6.1	Suitability of section modulus	
	6.2	Optimum pre-stressing force and corresponding eccentricity	
	6.3	Safe cable zone	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the concept of pre-stressing, its casting techniques and applications.
2 Describe difference between RCC and PSC elements and their behavior.
3 Estimate the loss of stresses in pre-stressing steel.
4 Analyze and design the pre-stressed concrete element using relevant IS Code.

Site Visit:

The learners shall visit a construction site of pre-stressed concrete and submit a report.

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books/Code:

1 Prestressed Concrete: *N. Krishna Raju*, Tata McGraw-Hill Publishing Company Limited, New Delhi

2 Fundamentals of Prestressed Concrete: *N.C Sinha* and *S.K. Roy*, S. Chand Publishing

3 Prestressed Concrete: *N. Rajagopalan*, Narosa Publishing House

4 Prestressed Concrete Structures: *P. Dayaratnam*, Oxford and IBH Publishing Co. Pvt. Ltd.

5 Prestressed Concrete: *S. Ramamrutham*, Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi

6 IS code: IS:1343-2012

Reference Books:

1 Design of Prestressed Concrete Structures: T. Y. Lin and N.H. Burns, Wiley India Pvt. Ltd.

2 Design of Prestressed Concrete: *Arthur H. Nilson*, Wiley

Semester VII

Course Code	Course Name	Credits
CEDLO7012	**Department Level Optional Course-3: Applied Hydrology & Flood Control**	**03**

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
3	--	--	3	--	--	3

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 hrs	-	-	-	100

Rationale

This course deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It focuses on types and forms of precipitations. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows. It further describes the various techniques of estimating streamline flows. It also describes the importance of floods, flood routing and ground water hydrology.

Objectives

1. To explain the various processes involved in the hydrological cycle.
2. To measure rainfall, computation of average rainfall, various water losses etc.
3. To differentiate the various stream flow measurement and its importance.
4. To interpret the hydrograph and unit hydrographs, applications of unit hydrograph concept.
5. To evaluate various flood control methods, estimate design flood, and flood routing
6. To describe the concepts of ground water movement, steady and unsteady flow towards fullypenetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ contents	Periods
I	**1.1 Introduction:** Hydrological cycle, scope of hydrology, water budget equation, data sources.	8
	1.2 Precipitation: Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration - Frequency	

	relationship, Probable Maximum Precipitation.	
II	**2.1 Abstractions from Precipitation:** Evaporation and transpiration, evapo-transpiration, interception, depression storage, infiltration and infiltration indices, determination of water losses.	6
	2.2 Stream Flow Measurement: Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	
III	**3,1 Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts	6
IV	**4.1 Hydrograph Analysis:** Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	7
V	**5.1 Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor. Flood routing: Hydrologic and hydraulic routings.	6
VI	**6.1 Ground Water Hydrology**: Yield, transmissibility, Darcy's law, Dupuitt's theory of unconfined flow, steady flow towards fully penetrating wells (confined and unconfined). Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	6
	Total	**39**

Contribution to Outcomes

On completion of the course, the learners will be able to:

1. Explain hydrologic cycle and various methods of Measurement of rainfall.
2. Calculate optimum number of rain gauge stations for average rainfall and missing rainfall over catchment
3. Describe various methods of measurement of stream flow and to calculate abstraction losses over the catchment
4. Develop rainfall runoff relationship and calculating runoff over catchment
5. Perform hydrologic and hydraulic routing
6. Calculate the discharge of well for confined and unconfined aquifer

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests – First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test). Average of marks will be considered for IA

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only four questions need to be solved in total

Recommended books:

1. Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-978-93-83656-89-9
2. Irrigation and Water Power Engineering: B.C. Punmia, Pande B.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi

3. Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House,Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5. Engineering Hydrology: *K. Subramanya*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Hydrology: *H. M. Raghunath*, New Age International Publishers, New Delhi
7. Elementary Hydrology: *V. P. Singh*, Prentice Hall
8. Engineering Hydrology: Principles and practice: *V. M. Ponce*, Prentice Hall

Semester VII		
Course Code	**Name of the Course**	**Credits**
CEDLO7013	**Department Level Optional Course 3: Appraisal & Implementation of Infrastructure Projects**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					**TW/ Pract/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

For any Civil Engineering project, a range of alternative schemes meeting project goals are feasible. Thus to identify the most suitable out of it, project evaluation has to be carried out in terms of financial viability, environmental impact, utility to the society, engineering feasibility, profitability, etc. This course is intended to make students aware of this evaluation (appraisal) criterion for any Civil engineering project. Students will understand the importance of feasibility studies and get acquainted to the process of preparing a project report, both being crucial role players while deciding the viability of a project. The professional construction engineering practice will be rendered meaningful if students learn about ways to raise project funds, their effective planning and optimum utilisation. This course is devised to help students in understanding financial and economic aspects of a project.

Objectives

1. To know the procedure of feasibility studies for any infrastructure project.
2. To learn the procedure of appraisals required for deciding the worthiness of any project.
3. To learn the procedure of forecasting demand and know the uncertainties involved.
4. To know the components and importance of technical & managerial appraisal.
5. To get acquainted with decision making tools like Break even analysis, SWOT analysis etc.
6. To get acquainted with different methods of project finance and implementation.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Hrs**
I.	**Construction Projects and Report Preparation**		03
	1.1	Classification of construction projects. Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis. Preparation of Project report.	
II.	**Project Appraisal**		06
	2.1	Importance and phases in a project development cycle for major infrastructure projects.	
	2.2	Importance of Appraisal, its need and steps involved in it.	
III.	**Market Appraisal**		09
	3.1	Importance and methods of carrying out demand analysis. Sources to gather project related information and ways to carry out market survey.	
	3.2	Methods to forecast demands. Uncertainties involved in demand forecasting.	
IV.	**Technical and Managerial Appraisal**		06
	4.1	Method to study the technical appraisal/viability of a project in terms of its location, type of land and intended use of building, technology requirements of the project, Size and complexity of tools and plants, raw materials to be used and their impact on the vicinity, energy requirements, water supply and disposal of effluents if any.	
	4.2	Study of managerial requirements of a project, Desirable organisational structure and hierarchy to manage as well as implement the project, Method of assessment of entrepreneurs.	
V.	**Financial analysis and Economic Appraisal**		09
	5.1	Various costs related to a project, Methods to determine the profitability of a project, Break even analysis.	
	5.2	Economic appraisal: Urgency, Payback period, Avg. Rate of return, Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VI.	**Project Financing and Implementation**		06
	6.1	Types and Sources of finance in local, National and International context. Issues related to project financing.	
	6.2	Agencies involved in the implementation of a project. Methods of implementation like Built, operate and Transfer and its other variants like B.O.O, B.O.O.T, B.L.T, EPC ,etc.	
		Total	**39**

Contribution to Outcomes

On successful completion of the course, the learners will be able to:

1) **classify** the projects and **describe** the phases involved in project formulation.
2) **prepare** a detailed project report on the basis of various feasibility studies and SWOT analysis.
3) **devise** a project's development cycle and get acquainted with the different appraisals in the process of deciding the worthiness of a project.
4) **exhibit** and **apply** the managerial skills and knowledge of financial aspects required during the implementation of projects.
5) **identify** various sources for project finance.
6) **know** the various agencies involved in project implementation as well as **select** the method of project implementation which is best suited for a particular project.

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will **be compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Recommended Books:

1) Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra (Tata McGraw Hill).
2) Infrastructure Development & Financing in India - N. Mani (New Century Publications).
3) Infrastructure & economic development - Anu Kapil (Deep &Deep Publications).
4) Construction Management: Planning and finance - Cormican D.(Construction press, London).
5) Engineering Economics – Kumar (Wiley, India).
6) Real Estate, Finance and investment - Bruggeman.Fishr (McGraw Hill).
7) The cost management toolbox; A Managers guide to controlling costs and boosting profits. - Oliver, Lianabel (Tata McGraw Hill).

Semester- VII

Course Code	Course Name	Credits
CEDLO 7014	**Department Level Optional Course 3: Analysis of Offshore Structures**	**03**

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			**End Sem Exam**	**Duration of End Sem. Exam**	**TW**	**PR**	**OR**	
Test-I	**Test-II**	**Average**						
20	20	20	80	03 hrs	--	--	--	100

Rationale

Offshore Engineering discipline deals with the design and construction of structures intended to work in the ocean environment. The majority of offshore structures are used in the Oil and Gas industry. offshore construction is the installation of structures and facilities in a marine environment. Civil Engineering graduates will be able to study analysis and design in the specialized field of ocean and coastal environment.

Objectives

The objectives of this course are

1. to explain the types and materials used in offshore structures.
2. to provide an understanding of the structural response of offshore structures based on both component and system
3. to address the general engineering analysis and design concepts of offshore structures

Detailed Syllabus		
Module	**Course Modules / Contents**	**Hrs.**
I	**Types of offshore structures**	05
	Types of offshore structures, planning and design aspects, Overview of functional, environmental and accidental loads for marine structures, with emphasis on wind - and wave induced loads.	
II	**Materials and their behaviour**	06
	Hydrodynamic interaction, Effects and dynamic response, Materials and their behaviour under static and dynamic loads, allowable stresses, various design methods and codes, design consideration, design loads.	
III	**Analysis of offshore structures**	06
	Basics of Hydrodynamics, Structural dynamics, Advanced structural analysis techniques, Statistics of extremes: Airy Wave Theory, Higher order wave theories, Irregular Sea States, Short and long term statistics of wind; static wind load, Aerodynamic admittance function and gust factor.	
IV	**Estimation of wave forces**	06
	The Morison's equation, wave force, lift force on members, wave slam, maximum force and moments using linear theory, Vertical Piles, Horizontal Bracings, Diagonal Front Face Bracings, Diagonal Side Face Bracings, wave forces on large diameter members, Froude-Krylov Theory, Diffraction Theory, Drift force, Spectral and statistical analysis of wave forces.	
V	**Vibrations**	10
	Mass-spring system, Free Vibrations with Damping, Forced Vibrations, Forced Damped Vibrations, Torsional Vibrations, Elements of single d.o.f. system, Dynamics of multi d.o.f. systems, Eigen values and vectors; Iterative and transformation methods; Mode superposition, Fourier series and spectral method of response of single d.o.f. systems, Vibration of bars, beams, Behavior of concrete gravity platform as a rigid body on soil as a continuum	
VI	**Corrosion and allowances**	06
	Corrosion and other allowances, consideration of stress concentration, Ingredient materials and protective measure, Behavior of concrete gravity platform as a rigid body on soil as a continuum	
	Total	39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

1. Explain the types and materials used in offshore structures
2. Evaluate of the structural response of offshore structures based on both component and system.
3. Apply general engineering and design concepts to offshore structures
4. Apply Morison's equations to calculate wave force, lift force, etc.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IAE

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume–I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 l GB, UK.
2. Deo M C (2013): Waves and Structures, http://www.civil.iitb.ac.in/~mcdeo/waves.html
3. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
4. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).
5. Brebbia C.A. and Walker, "Dynamic Analysis of offshore structures", Newness butterworth, London, 1978.
6. Sarpakaya T. and Isaacson M., "Mechanics of Wave Forces on Offshore Structures", Van Nostrand Rainhold, NewYork, 1981.

7. Hallam M.G., Heaf N.J. and Wootton, L.R., "Dynamics of Marine Structures", CIRIA Publicartions, Underwater Engg. Group, London, 1978.
8. Graff W.J., "Introduction to Offshore Structures", Gulf Publishing Co., Houston, Texas, 1981.
9. Clough R.W. and Penzien J., "Dynamics of Structures", IInd Edition, McGraw hill, 1992.
10. Simiu E. and Scanlan R.H., “wind effects on Structures", Wiley,New York, 1978.
11. Codes of Practices (latest versions) such as API R-2A, bureau Veritas etc.
12. Rules for the design, construction and inspection of fixed offshore structures, 1977. Defnorske Veritas
13. Energy Department, U.K., Guidance of Design and Construction of Offshore Installation, 1974.
14. O.C. Zienkiewicz, R., Wlewis and K.G. Stagg, Numerical Methods in Offshore Engineering, Wiley Interscience Publication, 1978.

Semester VII

Course Code	Course Name	Credits
CEDLO7015	Department Level Optional Course-3 Advanced Construction Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	--	--	--	100

Rationale

In today's times the construction activities are undergoing lots of changes/developments due to internal and globalized market demands of quality and faster completion of project works using modern techniques, use of modern and waste materials, and through mechanized construction. Today, we require high-capacity machines with better output and greater efficiency to make construction process less stressful. This course has been designed so that civil engineers would be able to use advanced construction technology. Student will be introduced to some emerging technologies in the field of Civil engineering which will make them more industry ready.

Objectives

1. To study and understand the latest construction techniques applied to engineering construction for sub structure.
2. To summarize the students about various techniques of super structure construction.
3. To give an experience in the implementation of new technology concepts which are applied in field of advanced construction in special structures.
4. To know the different methods of some advanced construction techniques and ground improvement techniques.
5. To present the new technology related to dredging system and its concepts related advanced construction technology.
6. To study different methods of rehabilitation and strengthening in construction to successfully achieve the structural design.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Sub Structure Construction**		06
	1.1	Box jacking, Pipe jacking, Underwater drilling, blasting, and concreting. Underwater construction of diaphragm walls and basement	
	1.2	Driving well and caisson, sinking cofferdam, cable anchoring, and grouting. Driving diaphragm walls, sheet piles	
	1.3	Laying operations for built-up offshore system, Shoring for deep cutting, large reservoir construction, and well points. Dewatering for underground open excavation.	
II	**Super Structure Construction for building**		06
	2.1	Vacuum dewatering of concrete flooring, Concrete paving technology	
	2.2	Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections, Erection techniques of tall structures, large span structures, launching techniques for heavy decks, in-situ prestressing in high rise structures, post-tensioning of the slab, aerial transporting, Handling, and erecting lightweight components on tall structures	
III	**Construction of Special Structures**		06
	3.1	Erection of lattice towers - Rigging of transmission line structures, Construction sequence in cooling towers, Silos, chimneys, skyscrapers. Construction sequence and methods in domes, Support structure for heavy equipment and machinery in heavy industries, Erection of articulated structures and space decks.	
	3.2	Roof truss: erection problems Building / Industrial component, Equipment and tackles used for erecting these. Plate girder Launching a portion of bridge girder, large span lattice girder. Erection of chimney, Erection of overhead tank.	
IV	**Advancement in Construction techniques**		08
	4.1	Building construction techniques: Zero energy building, green building, pre-engineering building, Solar Paints, Building Integrated Photovoltaic (BIPV), Earthquake Resisting Controls-Isolation and Dissipation.	
	4.2	Coastal construction techniques: Sound Proofing walls, water-resistant roofs, high-performance doors and windows, air and moisture barriers.	
	4.3	Road construction techniques: 3D Printing, Road Printer, smart roads	
	4.4	Ground improvement techniques: Advanced piling techniques - Stone Column, Vibro Floatation, Grouting, Geotextile application, Micro Piles, and Soil Nailing. Vertical drains-Sand Drains, Pre-Fabricated Vertical Drains. Thermal Methods- soil heating and soil freezing.	
V	**Dredging**		06
	5.1	Dredging System, Mechanism, Hydraulic dredger in waves, dredging equipment, Water & Booster System, dredging in the navigation system, Agitation dredging system, silt dredging system, water injection system,	

		Pneumatic dredging system, Amphibious & scrapper dredging system.	
	5.2	Advantages & Disadvantages of Various Dredging Systems, Production Cycle for Dredgers, Application, Capacity of dredgers, & its economical use, dredging economics	
VI	**Rehabilitation and Strengthening Techniques**		07
	6.1	Seismic retrofitting, strengthening of beams, strengthening of columns, strengthening of the slab, strengthening of a masonry wall, Protection methods of structures, Mud jacking and grouting for foundation, Micro piling and underpinning for strengthening floor and shallow profile, Subgrade waterproofing, Soil Stabilization techniques	
	6.2	Repair of steel structures, bridge, building, towers etc., monuments and historical structures. Prevention of water leakage in structures; Underwater repair; Durability of repairing material. Maintenance of underground railways.	
		Total	39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Evaluate the procedure of construction techniques for sub structure of major civil engineering projects.
2. Get a thorough knowledge of various stages of construction of super structure of major civil engineering projects.
3. Gain an experience in the implementation of new construction technology on engineering concepts which are applied in field Advanced construction technology in special structures.
4. Get a diverse knowledge of the different methods of advancement in construction techniques and ground improvement techniques.
5. Learn various dredging systems for major civil engineering projects.
6. Explain the theoretical and practical aspects of rehabilitation and strengthening techniques in civil engineering along with the design and management applications.

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test)

Average of marks will be considered for IA.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Roy Chudley and Roger Greeno , Construction Technology , Prentice Hall, 2005.

2 Dr. B.C. Punamia (2008); "Building Construction" Laxmi Publications (P) Ltd.ISBN13: 978-8131804285. 666p.

3 S. S. Bhavekatti (2012); "Building Construction" Vikas Publishing House Pvt Ltd. ISBN-13: 978-9325960794. 356p.

4 Peter. H. Emmons, "Concrete repair and maintenance illustrated", Galgotia Publications Pvt. Ltd., 2001.

5 S. P. Arora and S. P. Bindra (2010); "Textbook of Building Construction", Dhanpat Rai & Sons publication, ISBN-13: 978-8189928803. 688p

6 Sushil Kumar (2010); "Building Construction" Standard Publishes-Distributors. ISBN-13: 978-8180141683. 796p.

7 S.C. Rangwala, Building Construction, Charotar Publication Pvt Ltd. Anand

Reference Books:

1 Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008.

2 Peurifoy, Construction Planning, Equipment and methods —Tata McGraw Hill Publication

3 Mahesh Varma , Construction Equipment Planning and Applications –

4 R. Chudley (revised by R. Greeno), Building Construction Handbook, Addison Wesley, Longman Group, England, 3rd ed.

5 S.S. Ataev, Construction Technology, Mir Publishers, Moscow

6 Robertwade Brown, "Practical foundation engineering hand book", McGraw Hill Publications.

7 Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons

8 Jerry Irvine, Advanced Construction Techniques, CA Rocketr

Semester VII

Course Code	Course Name	Credits
CEDLO7016	Department Level Optional Course-3: Pavement Materials, Construction and Maintenance	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

Highway and airways mode of transportation contributes to the economical, industrial, social and cultural development of any country. For the design and construction of highway and airfield, it is imperative to know the properties of the materials such as soil, aggregates and bitumen used in the construction of pavements. The various tests are required to be conducted to evaluate the properties of these materials for the scientific design of the pavements and economic utilization of the different materials. The course also deals with the soil survey, stresses in soil and various ways and means of improving the soil and implementing techniques of improvement. The course also deals with the various surface and sub-surface drainage.

Objectives

1 To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards. To study the soil classification for highway engineering purpose as per different classification system.

2 To understand the concept of stresses in soil. To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.

3 To understand the requirements of aggregates as per IRC code.

4 To learn bituminous types and mix designs.

5 To understand the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements. To study the construction of the concrete roads and low volume roads

6 To learn basic principles of super pave technology of bituminous mixes

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Soil		05
	1.1	Soil-Classification methods	
	1.2	Tests on Soil: CBR test, effect of lateral confinement on CBR and E value of Subgrade soil, Consistency, Engineering Properties and Modulus of sub-grade reaction of soil, estimation of modulus of subgrade reaction, Static and cyclic plate load test, correction for plate size, correction for worst moisture content.	
	1.3	Soil classification as per HRB.	
II	Stresses in Soil		08
	2.1	Theories of elastic and plastic behavior of soils, Cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus.	
	2.2	Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for testing, Relation for Moisture content and Dry Density of Stabilized mixes, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes. (IRC: SP:89 (Part II)-2018)	
III	Aggregates		04
	3.1	Classification, requirements, Blending of aggregates, Importance of aggregate shape factor in mix design	
	3.2	Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials),	
IV	Bitumen, Tar and Bituminous Mix Design		09
	4.1	Binders: Requirements, criteria for selection of different binders, Temperature susceptibility, Bituminous emulsion and Cutbacks, fillers, extenders Polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance.	
	4.2	Bituminous Mix Design: selection of different grade of bitumen, skid qualities, types of bituminous surfaces, bituminous mix design, Marshall Stability test, design aspect of paving concrete. Experimental characteristics of road aggregate.	
V	Evaluation and strengthening		09
	5.1	Flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman beam deflections, skid resistance and measurement	
	5.2	Highway construction: Construction of WBM roads, Bituminous pavements, cement concrete roads, Reinforced concrete pavements construction.	
	5.3	Quality control (QC) and Quality assurance (QA) during construction of various pavements.	
	5.4	Low-Cost Roads (Rural Areas) (IRC-SP-20-2002) Classification of low-	

		cost roads, construction of low-cost roads.	
VI	Introduction to Super pave Technology		04
	6.1	Methods of selection of suitable ingredient for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test.	
	6.2	Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method.	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material in terms of standard engineering parameters.

2 Describe the stress distribution in subgrade soil and the various ground improvement methods.

3 Evaluate the requirements and desirable properties of the aggregate to be used in the construction of pavements.

4 Compare the characterization of different surface paving (Bitumen) materials as per IRC code.

5 Explain the various causes leading to failure of pavement and remedies for the same and the construction of the concrete roads and low volume roads

6 Apply basic principles of mix design of cement concrete and bituminous mixes.

Internal Assessment 20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average of marks will be considered for IA.

End Semester Examination 80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Highway Engineering: *Khanna, S.K., Justo, C,E.G. and Veeraragavan, A.,*Nem Chand and Brothers, Roorkee (10th Revised Edition, 2014)

2 Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B.Lal*, Khanna Publishers, New Delhi.

3 Highway Engineering, *Sharma, S.K.,* S. Chand Technical Publishers, New Delhi (3rd Revised Edition, 2013).

4 Principles of Transportation and Highway Engineering: *Rao, G.V.*, Tata Mc-Graw Hill Publications, New Delhi

Reference Books:

1 Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.,* John Wiley and Sons, Inc., New York.

2 Concrete Roads: *HMSO*, Road Research Laboratory, London.

Semester VII

Course Code	Course Name	Credits
CEDLO7021	Department Level Optional Course-4 Foundation Analysis and Design	03

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Foundation design is an important aspect of the vast field of civil engineering in general and geotechnical engineering in particular. A foundation designer has many diverse and important encounters with foundation design problems. The knowledge of foundation design is essential in design problems related to buildings, bridges, highways. tunnels, canals, or dams. The suitability of various types of foundations i.e. shallow foundation, pile foundation, well foundation etc. depends upon the bearing capacity of the soil, the pattern of stress distribution in the soil beneath the loaded area, the probable settlement of the foundation, effect of ground water, effect of vibrations, the magnitude of loads and ground water conditions etc. This course provides some important geotechnical aspects of the analysis and design of foundations.

Objectives

1 To estimate the vertical stresses in soil and to study the various practical applications.

2 To understand the design concepts for shallow foundations including strip and raft foundations and to understand applications of geocells.

3 To study the load carrying capacity and design of pile foundation.

4 To understand different types of well foundations and concept of floating foundations.

5 To analyze cantilever sheet piles including anchored sheet piles and to understand braced cuts system

6 To learn different types of machine foundations and understand the design philosophy.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Estimation of Stresses in Soils**		04
	1.1	Boussinesque and Westergaard's theories	
	1.2	Newmark Chart	
	1.3	Practical applications.	
II	**Shallow Foundation**		06
	2.1	Determination of bearing capacity of shallow foundation by IS Code method	
	2.2	Settlement analysis of shallow foundation by IS code method	
	2.3	Geotechnical design of shallow foundation on rock and weathered rock	
	2.4	Geotechnical design of raft foundation.	
	2.5	Improvement in the bearing capacity of footings using geocells	
III	**Pile Foundation**		07
	3.1	Introduction, necessity of piles, types of pile foundations.	
	3.2	Load carrying capacity of single and group piles	
	3.3	Pile load test as per IS 2911 (Part I & Part II)	
	3.4	Geotechnical Design of single pile and pile cap as per IS 2911 and IRC 78	
IV	**Floating Foundation and Well Foundation**		06
	4.1	Introduction to floating foundation, floatation, bottom elastic heave	
	4.2	Design of floating foundation on piles	
	4.3	Introduction to well foundation, forces acting on well foundation.	
V	**Sheet piles and Braced cuts**		08
	5.1	Cantilever sheet piles including anchored sheet piles in cohesionless and cohesive soils, lateral earth pressure diagram, computation of embedment depth	
	5.2	Difference in open cut and retaining wall theories, apparent earth pressure diagram	
	5.3	Design of reinforced soil retaining walls	
	5.4	Estimation of strut loads in braced cuts placed in cohesionless and cohesive soils.	
VI	**Machine Foundations**		08
	6.1	Introduction, Dynamic soil properties as per IS 5249	
	6.2	Types of machine vibrations	
	6.3	Basic principles of machines foundation	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Analyze vertical stress condition in soils.
2. Design a suitable foundation system.
3. Evaluate the safe allowable bearing capacity of shallow foundation and load carrying capacity of pile foundation under different soil conditions.
4. Explain concept of floating foundation.
5. Design different types of sheet piles.
6. Explain basic principles of machines foundation.

Internal Assessment 20 marks.

Consisting of Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination 80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1. Terzaghi K. and Peck R. B., "Soil Mechanics in Engineering Practice", Wiley and Sons, 1996.
2. Alamsingh, "Soil Mechanics and Foundation Engineering", Vol I & Vol II, Standard book House, 2013.
3. Holtz, R.D. & Kovacs, W.D., "An introduction to geotechnical engineering", Prentice Hall, 1981.
4. Taylor D.W., "Fundamentals of soil mechanics, Asia publications Bombay, 1967.
5. Das B. M., "Shallow Foundation- Bearing Capacity & Settlement" Taylor & Francis, 2009.
6. Das B. M., "Principles of Foundation engineering", PWS Publishing Company, 2012.
7. Winterkorn H. and Fang F. Y., "Foundation Engineering Handbook", CBS Publishers & Distributors, New Delhi, 1990.
8. Robert M. Koerner, "Design with Geosynthetics", Pearson Prentice Hall, 2005.
9. G.V. Rao & G.V.S.S. Raju, "Engineering With Geosynthetics", Tata McGraw-Hill Pub Co Ltd, 1990.

Reference Books:

1. Bowles J. E., Foundation Analysis and Design, McGraw-Hill Book Co, 2001.
2. Shamsher P. and Sharma H., Pile Foundations in Engineering Practice, Wiley and Sons, 1990.
3. Ranjan, Gopal & Rao, A.S.R., "Basic and applied soil mechanics", New Age International Pvt. Ltd., 2004
4. Kramer S. L. Geotechnical Earthquake Engineering, Prentice Hall, 1996
5. Swami Saran, Soil Dynamics and Machine Foundation (2nd Ed,), Galgotia Publication Pvt Ltd.
6. Duncan C. Wyllie, "Foundations on Rock" CRC Press; 2nd edition 2019.
7. N.V. Nayak, "Foundation Design Manual" Dhanpat Rai Publications, 2018.

Semester VII

Course Code	Course Name	Credits
CEDLO7022	Department Optional Course-4 Solid and Hazardous Waste Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Rationale

Management of solid and Hazardous waste is a challenge for all developed and developing nations. Measures like proper collection, segregation, treatment, and solid waste disposal needs more attention in today's world. To achieve sustainable development proper solid waste management should be subjected to various types of waste treatments for obtaining value added products. Robust implementation of planned facilities for reuse, recycling, maximum resource recovery from various waste facilities, combined with safe residual waste disposal through sanitary landfills, incineration and novel methods of composting is initiated.

Objectives

1. To describe functional elements of solid waste management and its need.
2. To explain the segregation and transportation of municipal solid waste.
3. To recognize waste disposal methods and energy recovery techniques.
4. To comprehend the necessary knowledge and concepts of landfill for disposal.
5. To demonstrate hazardous waste management through its safe handling and disposal.
6. To identify assorted types of solid waste.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Municipal Solid Waste Management**		06
	1.1	Sources, Types, Quantities, Composition, sampling of wastes, Properties of wastes, Numericals related to moisture content, density and Energy content, Problems and issues of solid waste management - Need for solid waste management- Awareness programme, Legal issues related to solid waste disposal	
	1.2	Functional Elements of SWM- waste generation (factors affecting), storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.7R concept	
II	**Waste Segregation, Storage, Collection and Transport**		06
	2.1	Segregation - wet and dry method, Volume reduction at source, Recycling and Reuse of waste, Methods of collection - House to House collection, On site storage of municipal solid waste, Hauled container and stationary container system, Collection routes; Optimization of transportation routes, Numericals on container and collection systems.	
	2.2	Transfer station -Significance, Site selection, Types, Material Recovery facility	
III	**Waste processing techniques and Energy Recovery**		06
	3.1	Waste transformation- Biological and Thermal Biological Conversion Technologies – Composting, Factors affecting for composting, Various Composting Methods as Indore and Bangalore, Vermi, Mechanical and In vessel composting, Numericals on aerobic and anaerobic composting	
	3.2	Thermal conversion technologies – Incineration, Pyrolysis, Gasification, Refuse derived fuel	
IV	**Landfills for Disposal of Waste**		07
	4.1	Landfill Classification-Sanitary, Secure and Bioreactor, Design criteria for landfill site selection, operation and maintenance, Landfill methods -Trench, Area, Slope	
	4.2	Leachate generation, Characteristics and it's control methods. Landfill gas management and landfill closure	
	4.3	IoT in solid waste management	
V	**Hazardous Waste Management**		07
	5.1	Sources, Characteristics and classification of hazardous wastes, Storage, Handling, Collection, Transportation and Minimization, Need for Hazardous Waste Management	
	5.2	Treatment and Disposal	

		Hazardous Site remediation – onsite and offsite Techniques. Hazardous waste management using secure landfill, Disposal practices in Indian Industries, Hazardous Waste Management Rules 2016.	
VI	**Assorted Solid Wastes**		
	6.1	**Biomedical waste** Need for Biomedical Waste Management, Sources, Classification, Storage and Segregation- Color coding, Collection and Transportation, Treatment and Disposal. Latest Biomedical waste management rules. **Electronic Waste** Types, Component separation, Collection, Recycling and Recovery, E-waste management techniques and Latest E- waste management rules	07
	6.2	**Plastic Waste** Problems related to plastic wastes, Plastic waste management-Recycling & recovery, Energy production, Plastic waste management-Rules and Regulation **Construction and Demolition waste** Composition, Recycling and reduction, Proper Management	

Contribution to Outcome

After the completion of the course the learner should be able to:

1. Acquire the knowledge of functional elements of solid waste management.
2. Illustrate solid waste collection system, route optimization techniques, transfer station and processing of solid waste.
3. Develop the ability to plan waste minimization and processing of solid waste.
4. Explain approaches to treat the solid waste in the most effective manner for sustainable development.
5. Discuss safe methods of handling, management and disposal of hazardous waste.
6. Summarize waste management techniques used for assorted solid waste

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications.
4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, Rakesh Johri, The Energy and Resources Institute.
6. Biomedical Waste Management in India: Jugal Kishore and G. K. Ingle, Century Publications
7. Advances in Construction and Demolition Waste Recycling Management, Processing and Environmental Assessment, Fernando Pacheco-Torgal, Yining Ding, Francesco Colangelo, Rabin Tuladhar, Alexander Koutamanis.
8. Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc. New York, 1993- Nabil Mustafa.
9. CPHEEO, "Manual on Municipal Solid Waste Management" Central Public Health and Environmental Engineering Organization, Government of India, New Delhi , 2000.
10. MSW Rules 2016," Swachh Bharat Mission and Smart Cities Program of India.
11. Hazardous and other Wastes Management Rules,2016

Semester VII

Course Code	Course Name	Credits
CEDLO7023	Department Level Optional Course-4: Ground Improvement Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

A geotechnical engineer often needs to design new structures or repair the structures on or in problematic soils in engineering practices. The types of soil at construction sites are not always totally favorable for supporting civil engineering structure such as buildings, bridges, highways, tunnels, retaining walls, dams, offshore structures and many more. Soil needs to be treated using ground improvement techniques to enhance the soil strength. Specific types of soil improvement techniques are required for different problematic soils and situations, such as expansive and collapsible soils, liquefiable soils, karst deposits, foundation on dumps and sanitary landfills, earthquake prone areas, etc. This course will deal with different ground improvement techniques, their principles, effectiveness, design issues and areas of applications.

Objectives

- To enable students to identify problematic soils, associated issues and need for ground improvement.
- To make the students understand shallow and deep compaction techniques, importance of pre-compression and vertical drains.
- To make the students understand different soil stabilization techniques.
- To make the students learn the concepts, purpose and effects of grouting.
- To make the students understand application of stone column technique.
- To provide students the concept of reinforced earth, soil nailing and ground anchors.

Detailed Syllabus

Module	Course Module/ Contents	Periods
I	**Introduction**	07
	Different types of problematic soils and concerns (inadequate mechanical properties, swelling and shrinkage - expansive soils, collapsible soils, marshy and soft soils, organic/ peaty soils, loose sandy or gravelly deposits, liquefiable soils, karst deposits, foundation on dumps and sanitary landfills, old mine pits, etc.); Need for ground improvement; Control of ground improvement works; Ground improvement techniques for different soil types (principles, applicability to various soil conditions, material requirements, equipments required, results likely to be achieved and limitations); Grain size ranges for different treatment methods; Classification of ground modification techniques; Factors affecting the selection of ground improvement techniques; Benefits/objectives of ground improvement techniques, Emerging trends in ground improvement techniques (Types and brief discussion on constructive use of waste materials, low cost technologies with soil and additives, Geosynthetics, biotechnical stabilization, etc.) **Note:** Refer IS 13094 (1992): "Selection of ground improvement techniques for foundation in weak soils – Guidelines"	
II	**Compaction and Consolidation**	07
	Shallow compaction: laboratory and field methods of compaction, compaction curve, advantages of compaction, effect of compaction; Deep compaction: objectives, brief discussion on dynamic compaction (types of dynamic compaction, evaluation of improvement), dynamic consolidation, dynamic replacement, Vibro-compaction or, Vibro-floatation, Vibro replacement, blasting; Precompression and vertical drains: Precompression or preloading (principle, settlement without and with Precompression), accelerated consolidation by sand drains, free strain and equal strain cases, design of sand drain layout; Brief discussion on prefabricated vertical drains (PVDs), advantages of PVDs over sand drains	
III	**Stabilization of Soil**	05
	Methods of stabilization; mechanical stabilization; lime, cement, fly-ash, bitumen, chemicals and polymer stabilization; Electrokinetic stabilization	

IV	**Grouting**	**06**
	Grouting technology, grout materials, choice of a grout material, classification, general relationship between permeability and groutability; Particulate grouts: characteristics of grout materials, characteristics of grout slurries; Non-particulate grouts: types of chemical grouts, salient features of chemical grouts, grout properties (mechanical properties, chemical properties, economic factors), penetrability and performance aspect of coarse and fine grouts, limits of groutability based on grain size distribution; Various applications of grouting. **Note:** Refer IS 14343:1996 "Choice of Grouting Materials for Alluvial Grouting – Guidelines"	
V	**Stone Columns**	**07**
	Some important features of stone column treatment: influence of soil type, influence of construction methodology, treatment depth, area of treatment; Basic design parameters: stone column diameter, pattern, spacing, equivalent diameter, replacement ratio, stress concentration factor; Failure mechanisms; Design considerations; Estimation of load capacity of a stone column (unit cell concept); Settlement analysis by the reduced stress method; Granular blanket; Field loading tests; Installation techniques of stone columns: non-displacement method, displacement method, vibro-replacement method; Vibrofloat and rammed stone columns; Methods of improving the effectiveness of stone column **Note:** Refer IS 15284-1 (2003): "Design and construction for ground improvement - Guidelines, Part 1: Stone columns"	
VI	**Reinforced Earth and Anchors**	**07**
	Theory of reinforced earth concept; Design principles of reinforced earth through Mohr circle analysis; Necessity of reinforced earth; Materials; Introduction to Geosynthetics: scope and definitions, multiple functions of Geosynthetics (Separation, Filtration, Drainage, Reinforcement, Protection (Cushion), Barrier/Containment/Waterproofing, Erosion Control), areas of applications; Introduction to soil nailing and ground anchors; Capacity of shallow horizontal strip anchor by using Mononobe-Okabe method.	
	Total	**39**

Contribution to Outcome

After successful completion of the course, students will be able to:

1. Identify the problems associated with the existing ground conditions and recognize the need for ground improvement.
2. Explain shallow and deep compaction techniques, pre-compression and vertical drains as well as estimate maximum dry density and consolidation settlement.
3. Evaluate soil stabilization and select the effective soil stabilization technique.
4. Apply knowledge of grouting as per IS 14343:1996.
5. Design stone column as per IS 15284-1 (2003).
6. Describe reinforced earth mechanism, multiple functions of Geosynthetics and evaluate capacity of anchors.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Recommended Books:

1. P. P. Raj (2016). "Ground Improvement Techniques", Second edition, Laxmi Publications (P) LTD.
2. M. R. Hausmann (1990). "Engineering Principles of Ground Modification", McGraw-Hill Inc.,US.
3. IS15284 (Part 1): Design and Construction for Ground Improvement–Guidelines: (Stone Column), Bureau of Indian Standards, New Delhi, (2003).
4. Nihar Ranjan Patra (2012). "Ground Improvement Techniques", Vikas Publishing.
5. S. L. Kramer (2013). "Geotechnical Earthquake Engineering", Pearson.
6. B. M. Das (1990). "Earth Anchors", Elsevier.

Reference Books and IS Codes:

1. IS 13094 (1992): "Selection of ground improvement techniques for foundation in weak soils – Guidelines"
2. IS 14343:1996 "Choice of Grouting Materials for Alluvial Grouting – Guidelines"
3. IS 15284-1 (2003): "Design and construction for ground improvement - Guidelines, Part 1: Stone columns"
4. R.M. Koerner (1984). "Constructional and Geotechnical Methods in Foundation Engineering (McGraw-Hill series in construction engineering and project management), McGraw-Hill Inc.,US.
5. FHWA Report No. Rd 83/026, (1983) Design and Construction of Stone Columns, Vol I.
6. B. M. Das (2011). "Principles of Foundation Engineering", 7th edition, Cengage Learning.
7. R.M.Koerner (1999). "Designing with Geosynthetics", 4th Edition, Prentice Hall, Jersey.

Semester – VII		
Course Code	Course Name	Credits
CEDLO7024	Department Level Optional Course-4: Green Building Constructions	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test–I	Test–II	Average						
20	20	20	80	3 hours	--	--	--	100

Rationale

Globally, buildings are responsible for a huge share of energy, electricity, water and materials consumption. As of 2018, buildings account for 28% of global emissions or 9.7 billion tonnes of CO_2. The United Nations' 2020 global status report and other sources detail that around 35 - 40% of globally generated energy was used by buildings; which also contributed to 33% of worldwide emissions. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, according to the United Nations Environment Program. Green building construction practices aim to reduce the environmental impact of building as the building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. As civil engineering graduates, it is of utmost importance to have a deep understanding of the concepts and technologies involved in the sustainable development with respect to the construction industry. It is also further desirable for the graduates to have an in-depth knowledge of the green rating systems as well as green auditing & green retrofitting – which will have tremendous scope in the future.

Objectives

1. To outline the environmental impact of buildings
2. To explain the concepts of sustainable development and green building
3. To summarize the features of green buildings
4. To explain green building rating systems
5. To describe green audit
6. To explain green retrofitting

Detailed Syllabus

Module	Course Modules / Contents		Duration
I	**Introduction**		3
	1.1.	Environmental impact of buildings, concept of sustainable development, concept of green buildings, necessity of green buildings, benefits of green buildings	
	1.2.	Overview of features of green building – design and construction efficiency, water efficiency, energy efficiency, materials efficiency, indoor environmental quality, waste reduction, operations and maintenance	
	1.3.	Examples of green buildings	
II	**Site Selection, Planning and Design**		8
	2.1.	Site preservation	
	2.2.	Passive architecture	
	2.3.	Soil erosion control	
	2.4.	Natural topography and on-site vegetation	
	2.5.	Preservation of transportation of trees on-site	
	2.6.	Heat island reduction	
	2.7.	Optimization in structural design	
	2.8.	Innovation in design process	
III	**Water Conservation and Energy Efficiency**		10
	3.1.	Rainwater harvesting	
	3.2.	Water efficient plumbing fixtures	
	3.3.	Irrigation systems	
	3.4.	Wastewater treatment and reuse	
	3.5.	Water metering	
	3.6.	Wastewater reuse during construction	
	3.7.	Minimum and enhanced energy efficiency	
	3.8.	Commissioning plan for building equipment and systems and post-installation	
	3.9.	On-site and off-site renewable energy	
	3.10	Energy Metering and Management	
IV	**Green building materials and indoor environmental quality**		10
	4.1.	Sustainable building materials	
	4.2.	Use of certified green building materials, products & equipment	
	4.3.	Segregation of waste, organic waste management and handling of waste materials	
	4.4.	Fresh air ventilation	
	4.5.	CO_2 monitoring	
	4.6.	Day lighting	
	4.7.	Minimizing of indoor and outdoor pollutants	
	4.8.	Low-emitting materials	
	4.9.	Occupant well-being facilities	
	4.10	Indoor air quality testing, after construction and before	

		occupancy	
	4.11	Indoor air quality management	
V	**Green building rating systems**		4
	5.1.	Introduction to green building rating systems	
	5.2.	Overview of various green building rating systems	
	5.3.	Indian Green Building Council (IGBC) rating system – overview, benefits of new green buildings, overview of certification process and project checklist	
VI	**Green audit and green retrofitting**		4
	6.1.	Green audit: pre-audit, on-site audit and post-audit report	
	6.2.	Case study of any one green building audit	
	6.3.	Green retrofit – overview, components of green retrofit: integrated design, occupant behaviour, lighting retrofits, HVAC retrofits, window retrofits, green roof retrofits	

Contribution to Outcomes

On completion of this course, students will be able to:

1. Explain environmental impact of buildings, discuss the concepts of sustainable development & green buildings and overview the features of green buildings
2. Describe site selection, planning and designing of green buildings
3. Explain water conservation and energy efficiency in green buildings
4. Identify green building materials and indoor environmental quality
5. Apply green building rating systems
6. Describe green audit and green retrofitting

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only four questions need to be solved.

Recommended Books:

1. Green Building: Principles and Practices by Dr. Adv. Harshul Savla (Notion Press)
2. The Idea of Green Building by A. K. Jain (Khanna Publishers)
3. Green Building Guidance: The Ultimate Guide for IGBC Accredited Professional Examination by Karthik Karuppu (Notion Press)

4. Green Building Materials & Implementation by Dr. V. Murugesh (Notion Press)
5. Green Building Fundamentals by G. Harihara Iyer (Notion Press)

Reference Books/Links:
1. Indian Green Building Council (IGBC) web-site: https://igbc.in/igbc/
2. Leadership in Energy & Environmental Design (LEED) web-site: https://www.usgbc.org/leed
3. Green Building: Principles & Practices in Residential Construction by Abe Kruger and Carl Seville (Delmar Cengage Learning)
4. Green Building through Integrated Design by Jerry Yudelson (McGraw Hill)
5. Green Building Handbook: Volume 1: A Gude to Building Products and their Impact on the Environment by Tom Wooley, Sam Kimmins, Rob Harrison and Paul Harrison (Routledge Publishers)

Semester VII

Course Code	Course Name	Credits
CEDLO7025	Department Level Optional Course- 4: Legal Aspects in Construction	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	--	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Construction industry is one of the most regulated industries in the World and subjected to various laws, rules, and regulation and ethical standards. A civil Engineering graduate must be able to understand and interpret these laws and navigate through these environments with utmost certainty and responsibilities.

The syllabus of this course has been designed to give preliminary introduction to Civil Engineering about legal aspects in construction industry. Along with this, the course intend to help students understand various aspects of contracts, tenders and roles & responsibilities of various involved individual and parties.

Objectives

1 To explain needs of various laws and legislation related to Construction Industry.
2 To summarize application of various Contracts and their forms (Documents)
3 To describe application of various Tenders and their forms (Documents)
4 To understand needs & Methods of arbitration and dispute resolution mechanism
5 To explain needs health, safety and labour laws associated with Construction Industry
6 To describe needs of Environmental protection and ethics in Construction Industry

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction to Legal Aspects in Construction Industry**		6
	1.1	Need of laws in the construction industry. Role of Builders, Engineers, Architects and Contractors.	
	1.2	Need for legislation. Important Laws related to construction industry: Indian Contract Act 1872, Labour laws, The Building and Other Construction Workers Act, 1996, The Environment (Protection) Act, 1986.	
II	**Contracting in Construction**		8
	2.1	Contract: Definition, Purpose and Sanctity of Contract, Classification of Construction Contracts and their advantages and disadvantages: Lump-Sum Contract, Unit Price Contract, Cost-Plus Contract and Target Contract. Types of Documents (Forms) in a Construction Contract.	
	2.2	Contract Management: Indian Contract Act- 1872, Breach of Contract and Professional ethics to be followed by Contracting Parties.	
III	**Tendering in Construction**		6
	3.1	Tender: Definitions. Requisites of a Valid Tender Types of Tendering: Open Tendering, Selective Tendering and Negotiated Tendering.	
	3.2	Tender Documents, Scrutinization process, Award, acceptance, Bidding models & bidding strategies. E-Tendering process of PWD.	
IV	**Arbitration and Dispute Resolution**		6
	4.1	Claims & disputes, Standard methods of resolving disputes.	
	4.2	Dispute Resolution Board (DRB) – Necessity, formation, Functioning, Advantages etc	
	4.3	Arbitration & conciliation Act -1996 – Arbitration agreement, Arbitration process, duties & powers of an arbitrator, rules of preparing evidence, Publication of an award.	
V	**Health, Safety and Labour Laws**		6
	5.1	Safety rules on construction sites. Roles and responsibilities of owner, contractor and engineers on site.	
	5.2	Important laws: BOWC Act 1996	
	5.3	Minimum Wage Act, 1948	
	5.4	GST Tax Act 2017	
VI	**Environmental Protection and Ethics**		7
	6.1	Impact of construction industry in global warning and climate change. Environmental impact assessment report and case study of any recent infrastructure project.	

	6.2	Paris agreement 2020 and Indian's Climate target as per Paris agreement.	
	6.3	Ethical responsibilities of Civil Engineers, contractors and other parties in construction.	

Contribution to Outcome

On completion of this course, the students will be able to:

1. Explain needs of various laws and legislation related to Construction Industry.
2. Describe application of various Contracts and their forms (Documents)
3. Describe application of various Tenders and their forms (Documents)
4. Evaluate needs & Methods of arbitration and dispute resolution mechanism
5. Explain health, safety and labour laws associated with Construction Industry
6. Apply needs of Environmental protection and ethics in Construction Industry

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four questions need to be solved.

Recommended Books:

1. Manual for Procurement of Works 2019 GoI, Ministry of Finance
2. PWD manual for E-tendering 2018 PWD, India
3. Construction contracts and claims - Simon M.S., McGraw Hill, New York
4. Construction contracts Management- NICMAR Publication India
5. Estimation and contracts B.S. Patil

Reference Books:

1. Construction contracts and claims - Simon M.S., McGraw Hill, New York
2. Construction contracts Management- NICMAR Publication India

Semester VII

Course Code	Course Name	Credits
CEDLO7026	Department Level Optional Course-4: Environmental Impact Assessment	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 hours	--	--	--	100

Rationale

Environmental impact assessment is the formal process used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior to the decision to move forward with the proposed action. An impact assessment may propose measures to adjust impacts to acceptable levels or to investigate new technological solutions. This subject covers the study of environmental assessment process, environmental auditing and provisions of various environmental acts of India.

Objectives

1 Students will learn about sustainable development
2 Students will learn different steps within environmental impact assessment
3 Students will learn how to use of EIA for various projects
4 Students will learn the need to assess and evaluate the impact on environment.
5 Students will learn about Environmental Audit
6 Students will learn Major principles of environmental impact assessment

Detailed Syllabus

Module	Course Module / Contents	Periods
I	**Environmental impact assessment** What is it, Environmental attitudes, Brief history of EIA, Significance of EIA, Role of EIA in planning and decision making process, objectives of EIA.	5

II	**Environmental assessment process** Assessment methodology, Socioeconomic impact assessment, Air quality impact analysis, Noise impact analysis, Energy impact analysis, Water quality impact analysis, Vegetation and wild life impact analysis, Cumulative impact assessment, Ecological impact assessment, Risk assessment.	8
III	**Environmental Impact Assessment Process** Basic concept behind EIS, Stages in EIS production: Screening, scoping, prediction, evaluation, reducing impact, monitoring, conclusions, typical EIS outline	5
IV	**Rapid EIA** Rapid EIA, when it is carried out, advantages and disadvantages	6
V	**Environmental Auditing** Definition, aims and objectives, audit principles, incentives to undertake audit, partial environmental audits, stages of implementing environmental audits, scope of audit	7
VI	**Provisions of various environmental acts of India** various environmental acts of India, Case studies	8

Contribution to Outcome

On completion of this course, the students will be able to:

1 Demonstrate the understanding of concept of Sustainable Development and justify the methods of achieving Sustainable Development.

2 Overview of assessing risks posing threats to the environment

3 List and evaluate different risks associated with given project

4 Conduct Environmental Audit

5 Explain the importance of stakeholders in the EIA process

6 Conduct different case studies/examples of EIA in practice

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Corporate Environmental Management: Welford R, University Press

2 Environmental Assessment: *Jain R K*, Mc-Graw Hill

3 Environmental Impact Assessment: *Harry W Conter*, Mc-Graw Hill

4 Environmental Impact Assessment – Handbook: *John G Rau* and *D C Wooren*, Mc-GrawHill.

5 Introduction to Environmental Impact Assessment, A Chadwick, Taylor & Francis , 2007

6 Environmental Impact Assessment, Barthwal, R. R. New Age International Publications

7 Environmental Impact Assessment, Larry Canter, McGraw-Hill Publications

Reference Books:

1 Strategic Environmental Assessment,R.Therirvel, E. Wilson, S. Hompson, D. Heaney, D.Pritchard, Earthscan, London , 1992

2 A Pracfical Guide to Environmental Impact Assessment, Paul, A Erickson,Academic Press , 1994

3 Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications

4 Environmental Impact Assessment: Theory & Practice, Wathern, P, Publishers-Rutledge, London, 1992.

Subject Code	Subject Name	Credits
CEDLO7027	Department Level Optional Course-4: Advanced Design of Steel Structures	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test	Test	Average						
20	20	20	80	--	--	--	--	100

Rationale

The civil engineering structures are subjected to different types of loading and their combination. Many of the structure are made of steel , these structure are design by working stress method and limit state method . The design method of different component are given in the syllabus are based on limit state method and working state method.

Objectives

- To understand the design philosophies of Working stress and Limit state methods and
- design of moment resistant connections.
- To explain the design concept of gantry girder
- To understand the analysis and design concept of round tubular structures
- To describe the design concept of different type of steel water tank
- To explain the design concept of lattice tower
- To describe the design concept of steel chimney.

Detailed Syllabus

Module	Sub – Modules / Contents	Periods
I	**Introduction to Steel Structure and Moment Resistant Beam End Connections:**	07
	Introduction to type of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM) , Limit state method and design of simple riveted connection. Design of moment resistant bolted and welded beam end connections by limit state method	
II	**Gantry Girder :**	06
	Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	
III	**Round Tubular Structural Members :**	06
	Properties of steel tubes, design of tension member and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports	
IV	**Elevated Steel Tanks and Stacks :**	08
	Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation,	
V	**Lattice Tower:**	
	Different configuration of lattice towers; loads acting on lattice towers, Analysis of lattice tower,	06
	Steel Chimney :	06
VI	Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation.	

Contribution to Outcomes

On completion of this course, the students will be able to

1. Analyze and design Moment Connection.
2. Analyse and design gantry girder by limit state method.
3. Analysis and design of tubular truss using IS code.
4. Analysis and design of Elevated water tank using IS code.

5. Analyze and design Lattice Tower using IS code.

6. Analyze and design Steel Chimney using IS code.

1 Theory Examination:-

1. Question paper will comprise of six question; each carrying 20 marks.
2. The first question will be compulsory.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

Term Work (this may be included in content beyond syllabus / optional)

The Term work shall consist of a Design report and detailed drawings on any two projects as indicated below:

1. Roofing system including details of supports using tubular section
2. Design of elevated circular tank with conical bottom steel tank.
3. Design of lattice tower or steel chimney.

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets.

Recommended Books:

1 Design of Steel Structures : N Subramanian, Oxford- University Press

2 Design of Steel Structures: Punamia, A. K. Jain & Arun Kumar Jain . Laxmi Publication

3 Design of Steel Structures: Dayaratnam, Wheeler Publication, New Delhi.

4 Design of steel structures: Krishnamachar B.S, & Ajitha Sinha D.

Reference Books:

1. Design of Steel Structures: Mac. Ginely T.
2. Design of Steel Structures: Kazimi S. M. & Jindal R. S., Prentice Hall of India.
3. Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.

4. Design of Steel Structures: Arya and Ajmani, New chand & Bros.
5. Relevant IS codes, BIS Publication, New Delhi
6. Steel structures, Controlling behavior through design: R. Englekirk, Wiley
7. LRFD Steel Design : William T. Segui, PWS Publishing
8. Design of Steel Structures: Edwin H. Gaylord, Charles N. Gaylord and James. Stallmeyer, McGraw-Hill

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7011	**Institute Level Optional Course – I : Product Life-cycle Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Module	Detailed Contents	Hrs
I	**Introduction to Product Life-cycle Management (PLM):** Product Life-cycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
II	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The	09

	Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
III	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
IV	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
V	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
VI	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Contribution to Outcomes:

Students will be able to

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questic ncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Life-cycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7012	**Institute Level Optional Course – I : Reliability Engineering**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Module	Detailed Contents	Hrs
I	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
II	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
III	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
IV	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08

V	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
VI	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Outcomes

Students will be able to…

- Explain and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out failure mode effect and criticality analysis

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7013	**Institute Level Optional Course – I : Management Information System**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Module	Detailed Contents	Hrs
I	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
II	**Data and Knowledge Management**: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
III	**Ethical issues and Privacy**: Information Security. Threat to IS, and Security Controls	7
IV	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
V	**Computer Networks Wired and Wireless technology**, Pervasive computing, Cloud computing model.	6
VI	**Information System within Organization**: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. **Acquiring Information Systems and Applications**: Various System development life cycle models.	8

Contribution to Outcomes

Students will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Evaluate the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Teaching Scheme

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7014	**Institute Level Optional Course – I: Design of Experiments**	**03**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Detailed Contents	Hrs
I	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
II	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
III	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
IV	**Two-Level Fractional Factorial Designs**	07

	4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
V	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
VI	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Contribution to Outcomes

Students will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation

and Discovery, 2nd Ed. Wiley

4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7015	**Institute Level Optional Course – I : Operations Research**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Module	**Detailed Contents**	**Hrs**
I	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	14

	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
II	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
III	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
IV	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
V	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
VI	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Outcomes:

Students will be able to

- Explain the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Describe the applications of integer programming and a queuing model and compute important performance measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7016	**Institute Level Optional Course – I : Cyber Security and Laws**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand and identify different types cyber crime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Module	**Detailed Contents**	**Hrs**
I	**Introduction to Cyber crime:** Cyber crime definition and origins of the world, Cyber crime and information security, Classifications of cyber crime, Cyber crime and the Indian ITA 2000, A global Perspective on cyber crimes.	4
II	**Cyber offenses & Cyber crime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cyber crimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
III	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spy-wares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
IV	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8

V	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
VI	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Outcomes

Students will be able to:

- Explain the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7017	**Institute Level Optional Course – I : Disaster Management and Mitigation Measures**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To describe role of individual and various organization during and after disaster
- To explain application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Module	**Detailed Contents**	**Hrs**
I	**Introduction** **1.1** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
II	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
III	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and	06

	how to proceed in due course of time, study of flowchart showing the entire process.	
IV	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
V	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
VI	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and Don'ts in case of disasters and effective implementation of relief aids.	06

Contribution to Outcome

Students will be able to…

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7018	**Institute Level Optional Course – I : Energy Audit and Management**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Module	**Detailed Contents**	**Hrs**
I	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
II	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
III	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.	10

	Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
IV	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
V	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
VI	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Outcomes:

Students will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected'during performance evaluation and recommend energy saving measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7019	**Institute Level Optional Course – I : Development Engineering**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Module	**Detailed Contents**	**Hrs.**
I	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
II	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee- linkage between Panchayati Raj, participation and rural development.	04
III	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the	06

	weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
IV	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
V	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
VI	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part

(a) from module 3 then part (b) will be from any module other than module 3)

4. **Only Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73^{rd} GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District
Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 40

Semester-VII

Course Code	Course Name	Credits
CEL701	Design and Drawing of Reinforced Concrete Structures	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	--	2	--	--	1	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
--	--	--	--	--	25	--	25	50

Course Objective:

1. To explain the LSM design procedure of G+ 3 RCC framed Building by application of IS code clauses including loading calculation, analysis and design of individual elements with detailing of reinforcements.
2. To explain the concept in the design of water tanks.
3. To explain the concept in the design of retaining walls.
4. To introduce the basics of structural dynamics, structural behavior under the dynamic load and the effect of damping.
5. To introduce earthquake resistant design approach.
6. To develop the practice of design using charts and tables from SP:16 published by BIS.
7. To introduce concept of Pre-stressed Concrete.

Course Outcomes:

At the end of the course, learner will be able to:

1. Design G+3 RCC framed building using IS code recommendations.
2. Design different types of water tanks with detailing of reinforcement.
3. Design different types of retaining walls with detailing of reinforcement
4. Apply the basic concepts of structural dynamics
5. Explain response of structure during an earthquake and calculate design forces.
6. Explain principles of Prestressed Concrete and its losses.

List of Tutorials and Assignments

Week (Activity)	Detailed Content	Hours
1st Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Drawing of structural plan on Sheet no. 1)	02
2nd Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Staircase)	02
3rd Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of simply supported and continuous one way and two-way slabs and detailing of reinforcement for slabs including staircase on sheet no. 2)	02
4th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of simply supported and continuous Beams and Detailing of reinforcement for beams on sheet no. 3)	02
5th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Columns and Detailing of reinforcement for columns on sheet no. 4)	02
6th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of isolated & combined footing and Detailing of reinforcement for footing on sheet no. 5)	02
7th Week (Assignment)	Assignment no. 1 Introduction to Structural Dynamics (Maximum 5 Questions)	02
8th Week. (Assignment)	Assignment no. 2 Earthquake resistant design of structures (Maximum 5 Questions)	02
9th Week (Tutorial)	Project – II – Design of Counterfort retaining wall Design of the elements of counterfort retaining wall using LSM	02
10th Week (Tutorial)	Project – II – Design of Counterfort retaining wall (Detailing of reinforcement of counterfort retaining wall on sheet no. 6)	02
11th Week (Assignment)	Assignment no. 3 Design of water tanks using WSM (Maximum 5 Questions)	02
12th Week (Assignment)	Assignment no. 4 Introduction to prestressed concrete Maximum 5 Questions	02
13th Week	Viva – Voce Examination	02

Assessment:

- **Term Work**

The Term work shall consist of neatly written design report on Project – I & II & reinforcement detailing on A2 size sheets of paper, detailed drawings using AutoCAD and Assignments 1 to 4. A visit to be conducted at RCC or Prestressed concrete construction site and a detailed report to be submitted by the groups of students. Students may be asked to check manual calculations with available structural design software.

Distribution of marks for Term Work shall be as follows:

Tutorial Work	:	15 Marks
Assignments & Site Visit Report	:	05 Marks
Attendance	:	05 Marks

- **End Semester Oral and Sketching Examination**

  Oral examination will be based on entire syllabus and sketching examination will be conducted for 60 minutes duration before oral examination.

Recommended Books:

1. Design of Reinforced Concrete Structures: *Dayaratnam, P;* Oxford and IBH.
2. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand& bro.
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House, New Delhi
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel; Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon, Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.
4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. Prestressed concrete : N. Rajgopalan, Narosa Publishers.
7. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
8. Relevant IS Codes: BIS Publications, New Delhi.

Semester VII

Course Code	Course Name	Credits
CEL702	Quantity Survey, Estimation & Valuation	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	--	2	--	--	1	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
--	--	--	--	--	25	--	25	50

Course Objective:

1. To emphasize the importance of relevant IS: 1200 - 1964 codes and understand measurement systems for various items of civil engineering structures
2. To draft the specifications for various items of work & determine unit rates of items of works by preparing rate analysis
3. To study the various methods of detailed and approximate estimates.
4. To calculate the quantity of earthwork by using various methods.
5. To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.
6. To understand the concept of valuation & to determine the present fair value of any constructed building at stated time.

Course Outcomes:

On completion of the course, the learners will be able to:

1. **Identify** current unit rates of various construction materials through market survey & also study District Schedule of Rates (DSR)
2. **Prepare** rate analysis of few important Items of work
3. **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures, including bar bending schedule, by referring drawings.
4. **Assess** the quantities of earthwork & **construct** mass haul diagrams.
5. **Draft** tender notice & **demonstrate** the significance of the tender as well as contract process.
6. **Evaluate** present fair value of any constructed building at stated time.

Activity Based Tutorials		
Tutorial No.	Tutorial	Tutorial Hours
1	Market Survey for rates of materials & items	02
2	Study of District Schedule of Rates & Prepare rate analysis of few important Items of work	02
3	Prepare approximate estimate of residential building	02
4	Prepare detailed estimate (Measurement sheet & Abstract Sheet) of any **two** of the following • RCC structure • Road work • Cross drainage work	02
5	Work out Steel quantity by using BBS	02
6	Work out earthwork volume in banking & cutting for a Road section	02
7	Draft Tender Notice for proposed construction Project & study tender documents & Conditions of contract	02
8	Prepare Valuation Report of any Civil Engineering Structure	02

Internal Assessment

Term work: - **25 Marks**

The term work shall consist of all tutorials enlisted in the syllabus
The use of quantity survey software and the use of worksheets/databases while solving some of the afore-mentioned tutorial is desirable.

Distribution of marks for Term Work shall be as follows:

Tutorials: 20 Marks **Attendance: 05 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

End Semester Oral Examination: - **25 Marks**

Oral examination will be based on Term-work & entire syllabus

Reference Books: -

1) Estimating, Costing, Specifications and Valuation: Chakraborty, M., Kolkata.
2) Estimating and costing: Datta, B. N., UBS Publications
3) Building and Engineering Contracts: Patil, B. S., University Press, Hyderabad.
4) Professional Practice: Dr. Roshan H. Namavati

<table>
<tr><th colspan="10">Semester - VII</th></tr>
<tr><td colspan="2">Course Code</td><td colspan="7">Course Name</td><td>Credits</td></tr>
<tr><td colspan="2">CEP701</td><td colspan="7">Major Project Part-I</td><td>03</td></tr>
<tr><td colspan="3">Contact Hours</td><td colspan="7">Credits Assigned</td></tr>
<tr><td>Theory</td><td>Practical</td><td>Tutorial</td><td colspan="2">Theory</td><td colspan="2">Practical</td><td colspan="2">Tutorial</td><td>Total</td></tr>
<tr><td>-</td><td>6</td><td>-</td><td colspan="2">-</td><td colspan="2">3</td><td colspan="2">-</td><td>3</td></tr>
<tr><td colspan="5">Theory</td><td colspan="4">Term Work/Practical/Oral</td><td rowspan="3">Total</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td><td rowspan="2">Duration of End Sem Exam</td><td rowspan="2">TW</td><td rowspan="2" colspan="2">PR</td><td rowspan="2">OR</td></tr>
<tr><td>Test–I</td><td>Test–II</td><td>Average</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>25</td><td colspan="2">-</td><td>25</td><td>50</td></tr>
</table>

Rationale

In the field of Civil Engineering, new problems arise every now and then; but a professional Civil Engineer must know how to precisely identify & state those problems, define the scope & objectives of the probable solution(s), carry out effective review of available literature in the domain of the problem and formulate a systematic methodology to solve the problem. Modern tools and multidisciplinary knowledge are vastly used nowadays for the effective solution of Civil Engineering problem. It is also important to work effectively & ethically as a team and communicate the work done in the form of written reports. The aim of this course is to acquaint the learners with all of the above-mentioned aspects of the Civil Engineering field by inculcating the process of research.

Objectives

1. To acquaint the learners to identify problems
2. To accustom the learners to formulate the scope and objectives
3. To familiarize the learners with the process of review of literature
4. To advice the learners to formulate a methodology
5. To accustom the learners to work as a team
6. To appraise the learners on proper documentation of work

Detailed Syllabus

1. A project group should consist of minimum 3 and maximum of 4 students.
2. The problem statement of the project should preferably be (but not limited to) from the domains of civil engineering.
3. The solutions to the problem may be multidisciplinary i.e., incorporating concepts, tools, techniques etc. of disciplines apart from Civil Engineering.
4. The project work may include:
    - a) Experimental Analysis
    - b) Design of Structures
    - C) Preparation of Working Drawing
    - D) Research on Novel Materials
    - E) Development of Working Models

F) Studies on Technical and Economic Feasibility
G) Application of Internet of things (IOT) and Software in field of Civil Engineering.
H) Application of any other innovative tools and techniques.

Guidelines for Project

- Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor
- Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of internal and external examiners appointed by the Head of the Department/Institute of respective Programme.

Contribution to Outcomes

On completion of this course, the students will be able to:

1. Review & comprehend literature in the selected domain
2. Articulate problem statement & identify the objectives
3. Identify existing methods or solutions to solve identified problem
4. Identify modern engineering tools & other resources to solve the problem
5. Formulate methodology to solve the identified problem
6. Effectively communicate their project work by writing reports & presentations

Semester-VIII

Semester VIII

Course Code	Course Name	Credits
CEC801	Construction Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	--	03	-	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3	-	-	-	100

Rationale

This course is intended to teach students the management skills to be applied during all the stages of Civil Engineering Project. The professional construction engineering practice will be rendered meaningless if service is not offered with a scientific approach and managerial practices. This course deals with the techniques to be applied for planning and scheduling projects, optimizing time-cost and other resources in construction, monitoring & ensuring quality and safety aspects in projects.

Objectives

1 To understand the basic functions and construction management.

2 To apply scheduling techniques such as CPM & PERT

3 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.

4 To understand allocating the resources and project monitoring

5 To know about safety and quality aspect of construction works.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction to Construction Management**		03
	1.1	Concept and Principles of Management, contribution by eminent personalities like F.W.Taylor, Henry Fayol and Elton Mayo towards growth of management thoughts.	

	1.2	Significance, objectives & functions of construction management	
II	**Construction Projects:**		03
	2.1	Role and unique features of Construction industry in economic development of country	
	2.2	Construction projects- Classification, Characteristics, Project life cycle	
	2.3	Roles and responsibilities of various agencies associated with a Construction project	
III	**Construction project planning & Scheduling:**		12
	3.1	Stages of planning in the view of owner / department as well as contractor.	
	3.2	W.B.S, Bar Charts its limitations and its uses, Milestone charts	
	3.3	Network-Terminology, Network Rules, Fulkerson's rule, Precedence network.	
	3.4	C.P.M- Activity & event with their types, activity times, event times, Critical path, forward pass, backward pass, float & its types.	
	3.5	P.E.R.T- Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project.	
IV	**Resources Management & Allocation :**		08
	4.1	Material Management- Importance, objectives and functions of material management. Inventory control, A-B-C analysis and E.O.Q.	
	4.2	Human Resource Management- Importance, objectives and functions	
	4.3	Resources Allocation Methods- Resource levelling and Smoothening	
V	**Project Monitoring & Cost Control :**		08
	5.1	Network Updating- Purpose and frequency of updating.	
	5.2	Time and cost optimization in construction projects - Compression & decompression of network.	
	5.3	Common causes of time over run & cost overrun & Corrective measures.	
VI	**Construction Safety, Quality Control & Labour Acts:**		05
	6.1	Common causes of accidents on construction sites, costs of accident and precautionary measures to avoid accidents.	
	6.2	Introduction to O.S.H.A. Occupational health hazards & Health Campaign in construction industry.	
	6.3	Concept of Quality and quality control.	
	6.4	Importance of labour acts as applicable to Indian construction labour such as Payment of wages act, Minimum wages act, Workmen's compensation act.	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.
2 Prepare feasible project schedule by using various scheduling techniques.
3 Gain knowledge of managing various resources & recommend best method of allocating resources to the project
4 Develop optimum relationship between time & cost for construction project
5 Implement quality & safety measures on construction sites during execution of Civil Engineering projects.
6 Describe the importance of labour acts.

Internal Assessment: 20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination: 80 marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions needs to be solved.

Recommended Books:

1 Construction Engineering and Management: S. Seetharaman.
2 Construction Planning & Management – Dr. U. K. Shrivastava.
3 Construction Projects planning and Management: P. S. Gahlot and Dhir New Age International (p) Publishers
4 Construction Project Management: Chitkara K. K. Tata McGraw Hill
5 Handbook of Construction Management: P K Joy, Macmillan, India
6 Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley

Reference Books:

1 Construction Hazard and Safety Handbook: King &Hudson, Butterworth
2 Professional Construction Management: Barrie D.S. & Paulson B C, McGraw Hill
3 NPTEL: Civil Engineering-NOC: Principles of construction https://nptel.ac.in/courses/105/104/105104161/

Semester VIII

Course Code	Course Name	Credits
CEDLO8011	Department Level Optional Course-5: Bridge Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3Hr	-	-	-	100

Rationale

In the age of increase in traffic load and rapid transportation, bridges are very important part of nation's transportation infrastructure associated with the economic growth. Bridges allow for roads and railways to cross over obstacles such as rivers, valleys or other roads etc. Bridges are being built mainly with reinforced concrete, pre-stressed concrete or structural steel depending on various factors such as environment ; site conditions, nature of loads and spans etc. The civil engineering profession is much concerned with proper planning, design, construction, maintenance, repairs and rehabilitation of bridges which are of utmost importance.

Objectives

1 Learner will be able to take the appropriate decision in respect of selection of site, type of bridge superstructure, sub structure, bearing, foundation, launching method of girder and construction methods as per conditions.

2 Learner will be able to analyze and design reinforced concrete culverts and pre-stressed concrete bridges using relevant IRCs.

3 Learner will be able to analyze and design lattice girder steel bridge for railway loading using relevant Bridge Rules and IRS code.

4 Learner will be able inspect the bridge and understand general aspects of repairs and rehabilitation.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction of Bridge Engineering**		02
	1.1	Types of bridges and their classification, components of a bridge	

	1.2	Selection of suitable site (data required and investigations)	
	1.3	Economic span	
II		**IRC loads, their distribution and design of superstructure for roadway bridges using limit state method**	20
	2.1	IRC loads: IRC-Class AA and 70R tracked vehicle, Class-A and Class-B train of vehicles	
	2.2	Design of RC culvert	
	2.3	Preliminary design of balanced cantilever bridge	
	2.4	Design of PSC deck slab bridge	
	2.5	Design of PSC I- girder bridge.	
III		**IRS loads, analysis and design of steel lattice girder bridge for broad gauge railway**	8
	3.1	Various IRS loadings, analysis of steel lattice girder bridge for broad gauge loading	
	3.2	Design guidelines for main components (top chord, bottom chord, diagonal member, end post) of steel lattice girder bridge [Numerical not expected]	
IV		**Substructure**	4
	4.1	Types of foundations and their choices, well foundation, pile foundation	
	4.2	Types of piers & abutments and their shapes, wing walls	
	4.3	Need of bearing, types and suitability	
V		**Erection of girder and construction methods**	2
	5.1	Various methods of erection of bridge girders	
	5.2	Cantilever method of construction of bridge	
VI		**Inspection and repairs of bridges**	3
	6.1	Categories of bridge inspection and instruments	
	6.2	General aspects of repairs, retrofitting and rehabilitation	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Choose the suitable type of bridge according to site condition.
2 Design RC Culvert and RC balanced cantilever bridge using relevant IRCs.
3 Design prestressed concrete deck slab bridge and I-girder bridge using relevant IRCs.
4 Design steel lattice girder bridge using IRS loading.
5 Choose different bearings, foundations, piers and abutments based on their suitability.
6 Choose method of erection of bridge superstructure and repair techniques of existing bridges.

Site Visit/ Field Visit:

The learner shall visit an under construction prestressed concrete bridge or steel lattice girder bridge site and prepare a detailed report on the same.

20 Marks

Internal Assessment Examination

Consisting of two compulsory Class Tests. First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

5 IRC: 6, IRC: 112 and IS: 1343 are allowed in the examination.

Recommended Books:

1 Design of Bridges: *Raju N. K.*, Oxford and IBH

2 Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill

3 Design of Bridge Superstructures: *T.R. Jagdeesh* and*M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi

4 Comprehensive Design of Steel Structures: Dr. B C Punmia, Ashok Kumar Jain and Arun Kumar Jain; Laxmi Publications (P) Limited

IRC Codes:

IRC: 5- 2015, IRC: 6- 2017, IRC: 78-2014, IRC: 83-(Part-I)-2015, IRC: 83-(Part-II)-2018, IRC: 83-(Part – III)-2018, IRC: 112-2020, IRC:123-2017, IRC SOR17-1996, IRC SOR18-1996, IRC SP13-2004, IRC SP37-2010, IRC SP40-1993, IRC SP54-2000, IRC: SP105-2015

IRS Codes:

Bridge Rules: Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges -2014

Indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic (steel bridge code) -2017

Reference Books:

1 Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill

2 Essentials of Bridge Engineering: *Victor D.J*, Oxford and IBH

3 Bridge Engineering Handbook: *Chen W. F. and Duan L.*, CRC Press, 2000

4 Bridge Bearings and Expansion Joints: *David Lee*, E & FN Spon

Semester VIII

Course Code	Course Name	Credits
CEDLO8012	**Department Level Optional Course-5: Design of Hydraulic Structures**	03

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--		03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam (Hours)	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3	--	--	---	100

Rationale

Hydraulic structures are the structures designed to retain, convey, control, regulate, mix and dissipate the energy of water. Such structures are constructed in all domains of water engineering; primary domains being water quantity management (water supply, irrigation, hydro power, flood control, drainage, navigation, socio-economic and recreational use), water-quality management and various transportation aspects. While the course emphasizes the “WHY” aspect; e.g., design of multi-purpose reservoirs and canal works, it also examines the “HOW” aspect of hydraulic structures. It is only through this mindful approach that the engineer can determine the advantages of a proposed design for a specific application.

Objectives	
1	To understand the reservoir and planning of reservoir, different zones, capacity and sedimentation control.
2	To convey the knowledge on the various types of Dams, utility and adaptability of various dams.
3	To develop understanding of the various causes of failure, design criteria and stability analysis of Gravity & Embankment dam.
4	To understand Spillways and Energy dissipators, their applicability.
5	To impart knowledge of canal headworks, canal regulation works and cross drainage works

Detailed Syllabus

Module	Course Module / Contents	Periods
I	**Reservoir Planning and Management:** Purpose of reservoir, classification of Reservoir, site selection, Investigation works for reservoir, storage zones storage capacity of reservoir, Yield and capacity of reservoir, mass inflow curve and demand curve, Determination of reservoir capacity, determination of safe yield, reservoir losses, reservoir sedimentation, sediment control, Multipurpose reservoirs, Flood Routing and its methods.	5
II	**Gravity Dams:** Various forces acting on gravity dam, Load combinations for design, Stability requirements& modes of failure, principal and shear stress, Profile of dam- elementary and practical profile, low and high gravity dam, Limiting height of gravity dam, High and Low gravity dam, Design of gravity dams, Galleries, Joints, Keys, Water seals, crack control in concrete dams.	10
III	**Arch and Buttress Dams:** Types of arch dams, forces acting on arch darn, design of arch dams, types of buttress dams.	4
IV	**Earth and Rock Fill Dams:** Types of earth dams, causes of failures of earth dams, design criteria, section of earth dam, downstream drainage system, seepage analysis, phreatic line, Stability analysis, stability of d/s slope during steady seepage, stability of u/s slope during sudden drawdown, stability of u/s and d/s slopes during construction, slope protection, seepage control measures, design considerations in earthquake regions, types of rock fill dams.	9
V	**Spillways and Flood Control Works:** Introduction, Necessity of spillways, location of spillway, design consideration of main spillway, Classification of spillways, straight drop spillway, design principles of ogee spillway, Chute spillway, Side channel spillway, conduit spillway, Siphon spillway and shaft spillway, energy dissipation below spillways, location of hydraulic jump and its	6

	characteristics, design of bucket type energy dissipator and stilling basin,. Crest gates, types, advantages, design of radial gate, outlet works.	
VI	**Miscellaneous Topics:**	5
	Diversion head works-Component parts, functions, weirs and barrages, Bligh's Creep theory, Lane's weighed theory, Khosla's Theory. Canal regulation works - classification, Sarda type fall, Head regulators and Cross regulators, Canal escape. Cross Drainage Works-Types, classification of aqueducts and syphon aqueducts	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the Reservoir planning, storage capacity, Sedimentation & Reservoir losses.
2 Carry out the stability analysis of Gravity & Earth Dam.
3 Explain the causes of failure of various dams & their design criteria.
4 Design an ogee spillway.
5 Suggest suitable energy dissipation measures.
6 Describe the various minor irrigation structures such as Weirs & barrages, Canal Regulators and Cross-drainage works.

Internal Assessment_20 Marks

Consisting Two Compulsory Class Tests - First test of 20 marks based on approximately 40% of contents and second test of 20 marks based on remaining contents (approximately 40% but excluding contents covered in Test I). Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination_80 Marks

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1) Question paper will comprise of a total six questions, each carrying 20 marks.
2) Question 1 will be compulsory and should cover maximum contents of the curriculum.
3) Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4) Only Four questions need to be solved.

Recommended Books:

1. Irrigation and Water Power Engineering: B.C. Punmia, PandeB.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
3. Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.

Reference Books:

1. Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
2. Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
3. Design of Small Dams: USBR.
4. Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
5. Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester VII

Course Code	Course Name	Credits
CEDLO8013	**Department Level Optional Course-5: Construction Safety**	**3**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	-	-	3	-	-	3

Theory					Term Work/Practical/Oral			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	**Test-II**	Average						
20	20	20	80	3 Hrs	-	-	-	100

Rationale

The primary goal of this course is to have students learn that a "culture" of safety needs to be developed within companies for a safety program to be effective. This course is more about managing the safety process than the details involved in the specific construction activities.

Students in this course will be provided an understanding of safe working practices, various training that are required to be undergone by employees to ensure safe working environment on construction sites, record keeping and maintenance of records, compliance with OSHA worker safety, codes and environmental safety laws, inspection procedures, and penalties for lack of conformance to safety laws.

Students will also learn procedures for recognizing hazards, CPR, site safety meetings and accident investigations.

Objectives

1	Plan to comply with safety documentation/procedures and legal requirements
2	Differentiate OSHA requirements for different work activities
3	Design Safety and Emergency response plans
4	Analyse the cost of Accidents
5	Design an effective company safety culture manual
6	Prepare complete corporate safety plan and site-specific safety plan containing hazard analysis of actual construction projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Construction Safety Management:**		04
	1.1	Role of top management, Duties & responsibilities of various officers on site, Responsibilities of general employees	
	1.2	Safety committee. Role of safety officer	
	1.3	General OSHA Requirements, Safety training, Safety campaign	
II	**Safety in construction operations and emergency response**		06

	2.1	Safety on various construction sites viz. buildings, dams, Tunnels, bridges, roads	
	2.2	Safety at various stages of construction. CPR, site safety meetings	
	2.3	Prevention of accidents. Safety measures. (preferably, site visit shall be arranged to understand the actual safety measures undertaken on construction sites)	
III	**Safety in use of construction equipment**		07
	3.1	Safety while operating construction equipment. vehicles, cranes, hoists and lifts	
	3.2	Safety of scaffolding and working platforms	
	3.3	Safety while using electrical appliances and explosives used.	
IV	**Accident prevention mechanisms**		12
	4.1	Hazard Recognition, Evaluation, and Control.	
	4.2	Fall Hazards & Fall Arrest- Ladders, Stairs, & Scaffolds	
	4.3	Electrical Safety Guidelines & Lockout, Tag-out. Struck-By and Caught-in-Between Hazards	
	4.4	Personal Protective gear, first aid on construction sites	
	4.5	Job-Site Exposure Hazards, Occupational Hazards	
	4.6	Environmental Extremes - extreme hot and extreme cold weather hazards	
	4.7	Fire Hazards and Fire fighting - Use of fire extinguishers and other fire control measures. Occupational Health Hazards	
V	**Labor Laws and legal requirements**		04
	5.2	Study of various existing national and state laws for worker safety and well-being	
	5.2	Accident Analysis, computation of costs of accidents for various scenarios, Worker's compensation insurance	
VI	**Study of Safety Policies**		06
	6.1	Study of safety policies, methods, equipment and training provided on any ISO approved construction company. Safety Standards and codes	
	6.2	Safety in office, working on sites of high rise construction, prevention of workplace violence	
	6.3	Observance of safety week, zero accident period, awards to best employee (for safety adherence), reprimands to habitual defaulters, etc.	

Contribution to Outcome	
On completion of this course, the students will be able to:	
1	Apply safety mechanisms and concepts for improving overall safety of construction sites
2	Demonstrate the various safety requirements
3	Explain the various techniques to prevent accidents.
4	Examine construction safety management.
5	Implement safety policies, methods and training on construction sites.
6	Practice safety in construction operations.
Internal Assessment	**20 Marks**

Consisting 2 Compulsory Class Tests - 1st test based on approximately 40% of contents and 2nd test based on remaining contents (approximately 40% but excluding contents covered in Test I)	
End Semester Examination	**80 Marks**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.	
1	Question paper will comprise of total six questions, each carrying 20 marks.
2	Question 1 will be compulsory and should cover maximum contents of the curriculum.
3	Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4	Only Four questions need to be solved.
Recommended Books:	
1	Construction Safety and Health (2nd ed), David L. Goetsch, Publish by Pearson ISBN-13: 978-0-13-237469-9, ISBN-10: 0-13-237469-2
2	Safety Management, Girmaldi and Simonds, AITBS Publishers, New Delhi
3	Construction Safety, Jimmy W. Hinze , Prentice Hall Inc.,
4	Construction Safety and Health Management, Richard J. Coble, Jimmie Hinze and Theo C. Haupt, , Prentice Hall Inc., 2001.
5	Construction Safety, R.K. Mishra, AITBS Publishers, New Delhi
6	Safety Management in Construction (Principles and Practice), S.K. Bhattacharjee, Khanna Publishers, New Delhi
7	Safety, Occupational Health And Environmental Management In Construction, S. C. Sharma and Vineet Kumar,
8	Construction Safety (English), by D.S.S.Ganguly and C.S.Changeriya, Chetan Publication; 2017th edition, ISBN-10 : 9386953293,ISBN-13 : 978-9386953292
9	Construction Safety Handbook - Davis V.S Thomasin K, Thomas Telford, London
Reference Books:	
1	Construction Safety Manual published by National Safety Commission of India
2	Safety Management in Construction Industry"- A manual for project managers- NICMAR, Pune
3	Construction Safety Handbook - Davis V.S Thomasin K, Thomas Telford, London
4	IS standards for safety in construction - Bureau of Indian Standards
5	OSHA Standards (CFR 1926) at www.osha.gov/readingroom.html

Semester VIII

Course Code	Course Name	Credits
CEDLO8014	Department Level Optional Course-5: Pavement Design	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	-	-	-	100

Rationale

The pavements are classified according to mode of transportation (highway and airways) and structural behaviour (flexible and rigid). The design of any pavement warrants the proper analysis thereof. The course deals with the various methods of the analyses and design of pavements.

Objectives

1 To study the different types of pavements depending upon the mode of transportation, factors affecting pavement design, and methods.

2 To understand the concept of analysis of stress, strain and deflection in pavement.

3 To enable the students to understand and analyse the mechanics related to flexible pavements as applicable for highways.

4 To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations. To enable the students to understand and analyses the concrete pavements as applicable for highways.

5 To enable the students to understand and analyse the mechanics related to flexible and concrete pavements as applicable for airports.

6 Evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements and introduce pavement management system

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction		04
	1.1	Classification of Pavement, Pavement structure and functional attributes, factors affecting pavement design.	
	1.2	Types of wheel loads for highways and airports, development of design method for highway and airport pavements	
II	Stresses in Pavement		06
	2.1	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL	
	2.2	Stresses in Rigid pavement: load and temperature stresses, combined stresses.	
III	Flexible Pavement Design		08
	3.1	Empirical methods using no soil strength criteria, empirical method based no soil strength criteria: CBR method as specified by IRC-37 -1970, 1984, 2001, 2012, 2018.	
	3.2	Road note 29 methods, AASHTO method, Asphalt institute method. Fatigue and rutting as a failure criterion.	
	3.3	Introduction to use of software for flexible pavement design.	
IV	Rigid Pavement Design		08
	4.1	Load and temperature stresses in rigid pavements Westergaard's, Bradburry's and Picket's concepts	
	4.2	Design steps as per IRC-58-2012,2015 method	
	4.3	Design of joints in rigid pavements	
	4.4	Introduction to use of software for rigid pavement design	
V	Design of Airport Pavements		08
	5.1	Factors affecting, types of wheel loads , aircraft loading, gear configuration and tyre pressure , development of design method	
	5.2	Design Methods: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. PCA methods	
	5.3	Joints and reinforcement requirement.	
VI	Design of Overlay		05
	6.1	Design aspects of flexible and rigid overlays design of overlays (IRC-81-1997)	
	6.2	Introduction to pavement management systems: Components of pavement management systems	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Explain the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
2 Describe the applications of the analysis in the design of pavements using different methods of pavement design.
3 Explain of the design of flexible pavement.
4 Describe the design of Rigid pavement.
5 Explain the design of airfield pavements and apply this knowledge in the field
6 Evaluate the different types of distresses occurring in the existing pavements and carry out the structural and functional evaluation of the pavements. Understand the pavement management system.

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Principles and Practice of Highway Engineering: *L.R.Kadiyali*, Khanna publications.
2 Highway Engineering: *Khanna S.K. and Justo* C.E.G. Nem Chand (Revised 10th Edition, 2014)
3 Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3rd Revised Edition, 2013)
4 Pavement Design: *Yoder* and*Witzech*, McGraw-Hill, 1982.

Reference Books:

1 Rajib Mallick & Tahar El-Korchi, *Pavement Engineering: Principles and Practice*, CRC Press , 2nd Edition, 2013
2 A. T. Papagiannakis, Eyad A Masad, *Pavement Design and Materials*, John Willey and Sons , 1st Edition 2008
3 Relevant Latest IRC, ASTM, AASHTO and other Codes, Manuals and Specifications
4 R Srinivasa Kumar, Pavement Design , University Press.
5 Pavement Analysis and Design: *Yang H. Huang*, Prentice Hall, New Jersey, 1993

6 The Design and Performance of Road Pavements: *Croney, David et al*, McGraw Hill.

Semester VIII

Course Code	Course Name	Credits
CEDLO8015	**Department Optional Course 5:** **Industrial Waste Treatment**	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Industrial wastewater is much more polluted than the domestic wastewater and hence has to be treate with the efficient choice of treatment units by preventing pollution of natural streams and rivers Wastewater treatments may not suffice only with primary treatments until they are modified an supplemented by additional techniques because of toxic chemicals. Industries are therefore generall prevented by legal aspects, from discharging their untreated effluents. It becomes mandatory fo industries to treat their wastewater in their individual treatment plant or common effluent treatment plan before discharging their waste on land, lake, river, municipal sewer, streams as the case may be.

Objectives

1. To enable the students to understand quality, characteristics, toxicity of industrial wastewater and its effects on streams.
2. To enable the students to understand the impact of industrial wastewater on natural streams.
3. To enable the students to understand waste minimization techniques for industrial wastewater.
4. To enable the students to understand the necessary knowledge and concepts of biological treatment and advanced/emerging techniques.
5. To enable the students to understand various industrial manufacturing process, effluents and treatments.
6. To enable the students to understand legislative framework for the remediation of industrial wastewater through environmental audit, environmental impact assessment and common effluent treatment plant.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction to industrial waste and treatments:** Sources and types of industrial waste-water, Effects of industrial waste-water on streams and waste-water treatment plants. Population equivalence, generation rates, characterization, important contaminants of concern from industries. Toxicity and Bioassay tests. Regulation for protection of streams. BOD Numericals.		06
II	**Stream Protection Measures:** Stream and effluent standards, stream sampling, stream sanitation, Procedures for improving stream water quality, zones of pollution, oxygen sag curve, Streeter Phelps Equation and numerical.		06
III	**Waste minimization:**		06
	3.1	Minimizing effects of industrial waste water: Volume reduction and Strength reduction	
	3.2	Equalization, Neutralization, Proportioning, Precipitation, Coagulation and flocculation. Flotation - Oil separation and Emulsion breaking.	
IV	**Waste-water treatments for industries**		06
	4.1	**Biological treatments:** Aerobic and Anaerobic biological treatment methods (Ponds, lagoons, UASB, RBC). Sludge dewatering techniques-Filter Press, Vacuum Filtration, Sludge thickening, Membrane filtration and Centrifuge.	
	4.2	**Advanced treatments:** Need for advance technologies, Automated Chemostat Treatment (ACT) Soil Biotechnology (SBT) Reed Bed Technology (RBT) Ozonation	
V	**Industries and waste-water management:** Raw material, Manufacturing process and flow-sheets, sources of effluents, characteristics, ETP, byproduct recovery for following industries: • Sugar • Distillery • Tannery		10

	• Dairy • Paper and Pulp • Metal Processing Industry (Electroplating)		
VI	**Legal Aspects, Environment Management Tools and Common Treatment Facility for industries**		05
	6.1	Environmental Impact Assessment, Case Study.	
	6.2	Environmental Audit for industries.	
	6.3	Common Effluent Treatment Plants (CETPs): Flow chart, Location, Need, Operation & Maintenance Problems and Economical aspects. Case study.	

Contribution to Outcome

Having completed this course, the students shall acquire the knowledge of biological treatment and will be able to decide and select precise treatment for particular waste. The students shall be able to determine and design the treatment facilities and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in the most effective manner for contamination removal.

After the completion of the course the learner should be able to:

1. Explain the impact of industrial wastewater characteristics on natural streams.
2. Analyze various stream protections measures to protect the natural streams.
3. Summarize waste minimization techniques for industrial wastewater.
4. Relate biological treatment concept and summarize various treatments along with advance technologies.
5. Describe waste water generated during manufacturing process and decide the suitable treatment for effluents.
6. Evaluate legislative framework for the remediation of industrial wastewater through environmental audit, environmental impact assessment and common effluent treatment plant.

Internal Assessment: **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination: **80 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of a total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature

4 Only Four questions need to be solved.

Recommended Books:

1. Industrial Pollution Control by Eckenfedlar W.W, 2017
2. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
3. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi.
4. Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.
5. Wastewater Treatment for Pollution Control and Reuse Hardcover – 1 July 2017, Soli. J Arceivala , Shyam. R Asolekar.
6. Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
7. Water Supply and Sewerage: E.W. Steel.
8. Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.
9. Introduction to Environmental Engineering: P. Aarne Vesilind, Susan M. Morgan, Thompson.
10. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.
11. Basic Principles of Wastewater Treatment Book ,Marcos Von Sperling
12. Industrial Waste Water Treatment Book, A. D. Patwardhan
13. Waste Water Treatment , M.N. Rao and Dutta

Reference Books:

1) Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
2) CPHEEO Manual on Sewage and Treatment.
3) Relevant Indian standard specifications and BIS publications.
4) Handbook of Water and Wastewater Treatment Plant Operations Book,y Frank R. Spellman

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CEDLO8016	**Department Level Optional Course-5: Soil Dynamics**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Rationale

In basic geotechnical engineering course normally various static loads are considered in the theories and analysis of soil. But practically many geotechnical applications require the knowledge of the behavior. properties and response of soil as a material which is subjected to various types of dynamic or cyclic time-dependent loadings. Some of the structures which are subjected to dynamic loadings are machine foundations, shallow and deep foundations, retaining structures, slopes, subgrade soil below railway, pavement, runway etc. This course provides the fundamental theoretical and computational aspects of dynamics for some important geotechnical problems and structures.

Objectives

1. To study fundamental concepts of vibrations, degrees of freedom and damping systems.
2. To study phenomena like liquefaction and their effects.
3. To study principals of machine foundation design and dynamic earth pressure theories on Retaining wall.
4. To learn test methods of evaluating dynamic properties of soil.
5. To know the earth pressure on retaining walls.

Detailed Syllabus

Module	Sub- Modules/Contents	Hrs
I.	**Introduction to Soil Dynamics** **1.1** Introduction to vibration (simple harmonic motion), Types of waves **1.2** Introduction to the concept of degree of freedom **1.3** Introduction to dynamic soil properties (IS4249) **1.4** Scope and objective, Nature and types of dynamic loading, Importance of soil dynamics.	04
II.	**Dynamic approach in different components** **2.1** Wave propagation in elastic rods, in an elastic finite medium and in semi-elastic half space **2.2** Wave generated by surface footing	05
III.	**Liquefaction of Soil** **3.1**Introduction to liquefaction of soils and its basic terminologies, criterion and factors affecting liquefaction of soil. **3.2** Liquefaction studies in triaxial shear, field studies on liquefaction **3.3** Evaluation of liquefaction potential using analytical method and SPT.	08
IV.	**Machine Foundation** **4.1**Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation, analysis of vertical and sliding vibration of a machine foundation **4.2** Practical design considerations and codal provisions.	06
V.	**Dynamic behavior of Machine Foundation** **5.1** Mass of soil participating in vibration. **5.2** Vibration isolation and screening methods, improvement of distressed machine foundation.	05
VI.	**Dynamic behavior of Retaining Wall** **6.1** Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils. **6.2** Basics of dynamic earth pressure on retaining walls conventional gravity type, reinforced soils, distribution of pressure, and point of application of the resultant, simple examples.	11
	Total teaching Hours	**39**

Course Outcome

On successful completion of the course, the students are expected to:

1. Demonstrate the knowledge of concepts, principles, and applications of soil response under dynamic loading.
2. Develop an ability to design with reference to code provisions and solve the practical soil problems subjected to vibrations.
3. Able to explain the concept of Liquefaction Potential of different types of soil
4. Provide an impetus to new developments in related dynamic topics.

5. Carryout field tests on soil to know the dynamic properties of soil.
6. Calculate the dynamic earth pressure on retaining walls.

Internal Assessment: **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents And second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

Theory Examination:-

- Question paper will comprise of **six** questions: each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of Entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub- module and contents thereof.
- There can be an internal choice in various sub-questions / questions to accommodate the Questions on all the topics /sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** Questions.
- Total **four** questions need to be attempted.

Recommended books:

1. Soil Dynamics: *Shamsher Prakash,* McGraw-Hill book company
2. Principles of Soil Dynamics: *Braja, M.Das*, PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: *Barkan, D.D.*, McGraw- Hill Book company
4. Geotechnical Earthquake Engineering", StevenL.Kramer ,PrenticeHallInc.
5. Vibrations of Soils and Foundations", E.E.Richartetal ,PrenticeHallInc.
6. Relevant IS codes

Semester VII

Course Code	Course Name	Credits
CEDLO8021	Department Optional Course 6: Repairs, Rehabilitation and Retrofitting of Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Structures need strengthening and repairs due to variety of reasons. Now a days different materials, techniques and machineries are used to improve the structures and prolong their serviceable life. A structure needs regular maintenance to perform satisfactorily during its lifetime. This subject deals with damage assessment, preparing a strengthening strategy of RCC , steel structures, Seismic Retrofitting and maintenance of heritage structures.

Objectives

1. To understand the concept of Repair of repair and its need.
2. To understand various causes of deterioration of concrete structure and Distresses monitoring techniques.
3. To understand various materials of repairs and their properties.
4. To understand various methods of repairs of concrete structure.
5. To understand various methods of repairs of steel structure.
6. To understand seismic retrofitting and maintenance of heritage structures.

Detailed Syllabus

Module	Contents		Periods
1	**Introduction**		03
	1.1	Need for repair, rehabilitation and maintenance of structure. Repair Management. Sustainable development.	
	1.2	Maintenance and it's importance, life cycle cost of structure	
	1.3	Heritage structure and need for their Rehabilitation	
2	**Damage Assessment**		08
	2.1	Causes of deterioration of concrete: Physical , Chemical and Mechanical causes.	
	2.2	Distresses monitoring, Visual inspection, Non Destructive Testing using Rebound hammer, Ultra sonic pulse velocity, Semi destructive testing, Probe test, Pull out test, Chloride penetration test, Carbonation, Carbonation depth testing, Corrosion activity measurement.	
	2.3	Types of cracks: Diagonal Cracks, Horizontal Cracks, Splitting Cracks, Corrosion Cracks, Plastic shrinkage cracks, thermal cracks	
	2.4	Crack Measurement techniques: Steel Ruler, Magnified Graticule , Plastic Tell Tale Glass Tell Tale Brass Screws and Caliper Displacement Transducer	
3	**Repair of Concrete Structures**		06
	3.1	Methods of crack repairs: Epoxy injection, Routing and Sealing of Cracks, Stitching Prestressing steel Drilling and Plugging Method Gravity Filling Method	
	3.2	Repair Materials: Essential parameters for repair materials.. Materials for repair: Materials for Surface Preparation, Chemical Rust removers for corroded reinforcement, Passivators for reinforcement protection, Bonding Agents, Structural Repair Materials, Non-structural Repair Materials, Injection grouts, Joint sealants,Surface coatings for protection of RCC. Premixed Cement concrete/mortars, Polymers/latex modified cement mortars, Epoxy resins	
	3.3	Corrosion repair methods: Cathodic Protection, Chloride Removal	
4	**Rehabilitation and Retrofitting Methods**		10
	4.1	Repair Stages: Concrete Removal and Surface Preparation, Fixing formwork, Bonding / passivating coat and repair application.	
	4.2	Repair Methods: Repairs using mortars/modified mortars, Epoxy based material repairs, Shotcrete, Ferro-	

		cement, Plate bonding, RCC Jacketing Propping and Supporting, Fibre Wrap Technique.	
	4.3	Foundation Rehabilitation Methods: Shoring, Raking shores, Flying shores, Dead shores. Underpinning. Slab jacking.	
5	**Repair of steel structures**		06
	5.1	Types and causes for deterioration - Preventive measures - Repair procedure - Brittle fracture - Lamellar tearing - Defects in welded joints -	
	5.2	Design and fabrication errors - Distress during erection - Causes and remedies	
	5.3	Repair methods for structures.	
6	**Seismic Retrofitting and Maintenance of Heritage Structures**		06
	6.1	Earthquake damages of buildings, their retrofitting and restoration. Effects of earthquakes.	
	6.2	Methods of seismic retrofitting, restoration of buildings Special care in repair and rehabilitation of heritage structures.	
		Total	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Describe the concept of repair and its need.
2. Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
3. Classify various materials of repairs and their properties.
4. Explain various methods of repairs of concrete structure.
5. Describe various methods of repairs of steel structure.
6. Explain seismic retrofitting and maintenance of heritage structures.

Internal Assessment: **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination 80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- Question paper will comprise of **six** questions: each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of Entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub- module and contents thereof.
- There can be an internal choice in various sub-questions / questions to accommodate the Questions on all the topics /sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** Questions.
- Total **four** questions need to be attempted.

Recommended Books:

1. CPWD Handbook on Repair and Rehabilitation of RCC buildings, Govt of India Press, New Delhi
2. Santhakumar A.R., "Concrete Technology" Oxford University Press, 2007, New Delhi
3. Bhattacharjee J, Concrete Structures Repair Rehabilitation and Retrofitting- 2019 , CBS Publishers & Distributors Pvt. Ltd.

Reference Books:

1. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" R and D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
2. Maintenance, Repair & Rehabilitation and Minor Works of Buildings P.C.Varghese, PHI Publications
3. P.K.Guha , Maintenance & Repairs of Buildings, New Central Book Agency (P) Limited,
4. R.Dodge , Concrete structures Concrete Structures Protection Repair and Rehabilitation, woodson

Semester VIII

Course Code	Course Name	Credits
CEDLO8022	Department Optional Course 6: Physico - Chemical Treatment of Water and Waste Water	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

This course introduces the principles and physico-chemical methods to control water and wastewater pollution. The aim of the course is to give a more fundamental and theoretical understanding of the specific unit processes, providing a better understanding of the principles of how they function and the degree of treatment that can be achieved. Students should be conversant with the sedimentation, coagulation, filtration, disinfection, advanced physico-chemical processes of water and wastewater. They should be conversant with de-watering and disposal of sludge.

Objectives

1. To study the impact of water and waste-water treatment on the environment.
2. To develop the rational approach towards the design of preliminary treatments.
3. To design primary treatment units.
4. To Explain and apply chemical unit techniques.
5. To impart knowledge about the advanced treatment for water and waste-water.
6. To study sludge de-watering & disposal techniques.

Detailed Syllabus

Module	Course Module / Contents	Periods
I	**Quality, Quantity of Water and Waste-water** Characteristics of water and waste-water, conventional water and waste-water treatment, Sampling and analysis, Health and environmental concerns, Components of waste water flows, sources, strategies for reducing interior water use and waste water flow rates, waste water reclamation and reuse	6
II	**Preliminary Treatment of Water and Waste-water** Screens: significance, Classification of screens, Design for head loss, Grit chambers: Gravity settling, stoke's law, Classification and Design Skimming Tank design and flotation	6
III	**Primary Treatment of Water and Waste-water** **Sedimentation:** Significance, Types of sedimentation tanks, Zones of settling, Design parameters, Design of sedimentation tank, Tube settlers **Filtration:** Mechanisms of filtration, hydraulics of filtration, different types of filters, filter clogging, filter washing, Design criteria of Rapid sand filter	8
IV	**Chemical units-Techniques:** Role of chemical unit processes in water and waste water treatment, **Coagulation:** Fundamentals, coagulant aids, polyelectrolytes, Design of flash mixer, power requirement **Flocculation:** Types of flocculation and flocculators, Design of flocculator, power requirement	6
V	**Advanced Physico-chemical Processes:** Softening, methods of softening, Chemical precipitation, Desalination, solar distillation, Reverse osmosis, Electrolysis Disinfection, Disinfection using chlorine and UV. Estimation of Chorine doses, Use of various forms of chlorine Removal of heavy metals, neutralization, Chemical oxidation of BOD and COD, Removal of colour, Gas stripping, Adsorption and Ion Exchange, Reverse osmosis, Membrane filtration, Activated carbon treatment	08
VI	**Sludge De-watering and Disposal** Sources of sludge, Estimation of bulk density of sludge, Principles of dewatering, Methods and suitability, thickening of sludge, Chemical conditioning, Elutriation of sludge, Vacuum and pressure filtration, sludge drying beds, Design of sludge drying beds	05

Contribution to Outcome

After the completion of the course the learner should be able to:

1. Explain the quality, quantity and treatment of water and waste-water.
2. Design preliminary units for treatment of water and waste-water
3. Evaluate the removal efficiencies of physico-chemical treatment units.
4. Identify optimized dose of chemical coagulation as well as disinfecting agents.
5. Apply advanced physico-chemical processes to water and waste-water.
6. Administer sludge de-watering and disposal process

Internal Assessment: 20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination 80 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of a total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature
4 Only Four questions need to be solved.

Recommended Books:

1. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition
2. Water Supply Engineering: S. K. Garg, Khanna Publication.
3. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers.
4. Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.
5. Industrial Pollution Control by Eckenfedlar W.W
6. Wastewater Treatment for Pollution Control and Reuse Hardcover – by Soli. J Arceivala (Author), Shyam. R Asolekar (Author)
7. Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
8. Water Supply and Sewerage: E.W. Steel.
9. Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.
10. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.
11. Basic Principles of Wastewater Treatment Book by Marcos Von Sperling
12. Industrial Waste Water Treatment Book by A. D. Patwardhan

13. Environmental Engineering: Peavy,H.S., RoweD.R.,
14. CPHEEO Manual on Water Supply and Treatment.
15. CPHEEO Manual on Sewage and Treatment

Semester VIII

Course Code	Course Name	Credits
CEDLO8023	Department Level Optional Course-6: Transportation System Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of Transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways and railways. This course is developed so as to impart the basic principles behind Railway Engineering, Airport Engineering, Water Transportation Engineering, Public Transportation system in respect of various types of materials used, function of component parts and planning principles.

Objectives

1 To enable the students to study the various elements of Transportation system in the country, NUTP and its Environmental consideration.
2 To study, plan and design different elements of airports and understand aircraft movement controls.
3 To explain and design various geometric elements of railways and study the elements of modern rails.
4 To Explain different components of water transport such as Ports, Harbors and Docks.
5 To study and Explain planning elements of public transport systems.
6 To Explain different components of bridges, planning of bridges and analyzing different hydrological elements of bridge.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction to Transportation System		05
	1.1	Role of transportation system in development of country, Different modes of transportation; their merits and demerits, present scenario of each mode in India. Different modes of Public Transportation modes available in Mumbai and Suburban areas with advantages and disadvantages of each.	
	1.2	Urban Transport: National Urban Transport Policy, Sustainable Transportation, Transit Oriented Development.	
	1.3	Environmental Guidelines for Transportation Infrastructure Projects: Environmental Impact Assessment, Identification of Impacts, Measures for offsetting adverse impacts.	
II	Air Transportation System		10
	2.1	Introduction: Aircraft: Types and components Airport: Site selection, classification, obstruction, zones and zoning laws, Environmental impacts and guidelines for Airport projects	
	2.2	Airport components: Requirements and functions of each Terminal building: Layout and planning, gate positions and gate capacity, blast consideration Apron and holding apron Taxiway: Design Runway: Configuration, orientation, wind rose diagram, basic runway length and corrections to runway length, Aircraft parking and hangars Airport drainage: Requirements and types	
	2.3	Aircraft movement control: Lighting and marking of runway, taxiway and other areas Air traffic control aids, en-route aids and landing aids	
	2.4	Planning of Heliports: Characteristics of Helicopter, Selection of site, Size of landing area, Obstruction clearance requirements, Marking and Lighting of Heliports.	
III	Rail Transportation System		08
	3.1	Introduction: Alignment of Railway lines, Engineering Surveys for new railway lines. Introduction to Railway Track Components: Requirements and functions of each	
	3.2	Geometrics- Gradient: Types Curves: Widening on curves, cant and cant deficiency Turnout: Components and design	
	3.3	Yards: Types and functions, Signaling- classifications,	

		interlocking of signals and points	
	3.4	Modern Rails: Characteristics of MAGLEV, Metro rails and mono rails, modernization of track and railway station, high speed trains (Bullet trains) and high-speed tracks	
IV	Water Transportation System		04
	4.1	Harbour: Classification, functions and requirements Harbour Infrastructures: Types of breakwaters, jetty, dock fenders, piers, wharves, dolphin, mooring accessories	
	4.2	Docks: Repair facilities, wet docks, lift docks, dry docks, gates for graving docks, floating docks	
	4.3	Port facility: Transit shed, warehouses, cargo handling, container handling	
V	Public Transportation System		06
	5.1	Introduction: Para Transit system, Street Transit system, Rapid Transit System.	
	5.2	Route and Schedule: Properties of good route set, stopping policy and Stop location, Properties of good schedule.	
	5.3	Capacity of Transit system: Capacity of Rapid Transit system, Capacity of Street Transit system.	
VI	Bridge Engineering		06
	6.1	Introduction: History and classification of bridge, Components of bridge, Requirement of Ideal bridge, Site selection and selection of alignment of bridges, Various loads on bridges	
	6.2	Low-cost Bridges: Introduction to Causeways, Culverts, Floating bridges etc.	
	6.3	Bridge superstructure and its types, Bearings and Joints on bridges Piers, abutments, Wing walls and approaches, Types of bridge foundations	
	6.4	Bridge Hydrology: Flood Discharge, Waterway, Economic span, Scour depth, Afflux.	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Compare different modes of transportation and describe National Urban Transport Policies.

2 Plan and design different elements of Airports, movements of aircrafts and helicopters.

3 Plan and design geometric elements of railway system and explain the elements of modern trains.

4 Explain different components of water transport.

5 Plan different public transport system, routing, scheduling and estimating transit capacity of the system.

6 Explain different elements of bridge and analyse various hydrological elements of bridge.

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only Four questions need to be solved.

Recommended Books:

1 Khanna S.K., Arora M.G., Jain S.S., Airport Planning & Design, Nemchand Bros., Roorkee
2 Saxena S.C., Railway Engineering, Dhanpat Rai & Sons, 1995
3 Srinivasan R., Harbours, Docks & Tunnel Engineering, Charotar Publishing House, Anand
4 Partha Chakroborty, Animesh Das, Principles of Transportation Engineering
5 Bindra S.P., Bridge Engineering, Dhanpat Rai & Sons

Reference Books:

1 Horenjeff Robert, The planning & Design of Airports, McGraw Hill Book Co.
2 Indian Railway Track: *Agarwal, M. M.,* Suchdeva Press New Delhi.
3 Planning Design of Airport: *Horonjeff Mckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
4 Docks & Harbour Engineering, Bindra S.P., Dhanpat Rai Publications,
5 Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House
6 Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi
7 Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.;* Prentice Hall India Learning Pvt. Ltd., New Delhi

Semester - IV

Course Code	Course Name	Credits
CEDLO8024	Department Level Optional Course-5: Smart Building Materials	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

A safe, comfortable, and sustainable built environment is highly desirable, as we spent most of our time in offices, factories, or homes. So smart building materials can play a vital role. Smart materials that are able to respond to an external stimulus have received great attention, especially in last two decades. These materials can change their dimensions, solubility, color, and shape, etc., upon a specific trigger. A wide range of smart materials including alloys, composites, gels, and polymers have been investigated for various applications from aerospace industry to medical technologies and now a days in the buildings and infrastructures. Smart materials can be designed with various responses and actuation mechanism based on the requirements of applications. Study of the importance and working principles of the smart materials is todays need. The concept of "smart" or "intelligent" materials, systems, and structures has been around for many years. A great deal of progress has been made recently in the development of structures that continuously and actively monitor and optimize themselves and their performance through emulating biological systems with their adaptive capabilities and integrated designs. The field of smart materials is multidisciplinary and interdisciplinary, and there are a number of enabling technologies-materials, control, information processing, sensing, actuation, and damping and system integration across a wide range of industrial applications.

Objectives

1. To study the importance of smart materials and technology
2. To Explain the types, properties of smart materials and learn to select appropriate materials.
3. To develop smart technology using smart materials
4. To Describe requirements of structural health monitoring
5. To understand the smart concrete
6. To learn applications of smart materials and technology via case studies.

Detailed Syllabus

Module	Course Modules / Contents	Periods
I	**Introduction to Smart Building Materials & Technology** History, importance and need, merits and demerits of smart building materials. Smart Structure system, Components, Importance of smart structures.	02
II	**Fundamentals of Smart Materials** Types and characteristics of smart materials:- **Property-changing materials:** Thermo-chromics, Photochromics, Mechanochromics, Chemochromics, Electrochromics, Liquid crystals, Suspended particle, Electrorheological, Magnetorheological **Energy-exchanging materials**: Electroluminescents, Photoluminescents, Chemoluminescents, Thermoluminescents, Light-emitting diodes, Photovoltaics, **Energy-exchanging (reversible) materials:** Piezoelectric, Pyroelectric, Thermoelectric, Electrorestrictive, Magnetorestrictive. **Miscellaneous Materials:** Shape Memory alloy, optical fiber, Construction chemicals, Sealants etc. Review of material, effect, working principle, advantages and disadvantages, application in Smart Structures, Use of alternative materials for structural steels and rebars.	09
III	**Energy Efficient Materials, Durability and Technology** Use of solar energy, wind energy, Smart window, Smart paints, Smart Wall skin, Smart roof. Green buildings and Green Material, Intelligent buildings. FRP rebars and its properties, smart lighting. Service life, Life cycle concept for structures and selection of materials for durability and sustainability. Use of Thermal and Sound Insulation systems and materials.	06
IV	**Smart Structural Health Monitoring**	09

	Important structural sensing parameters, Basic sensing system, Different types of sensors for monitoring stress, strain, temperature, moisture, displacements, vibration, corrosion etc. Active and passive structural health monitoring system. Specifically for buildings and bridges.	
V	**Smart Concrete:** Transparent concrete, Polymer modified concrete and mortars, self-healing concrete, self-compacting concrete, light weight concrete, pervious concrete, fiber reinforced concrete, temperature controlled concrete, coloured concrete- Constituents, Proportions, material properties, Importance and its application, Electrically conductive concrete, fire/ heat resistant concrete, acid resistant concrete, Ultra high performance concrete and its application in bridge engineering.	**08**
VI	**Applications of Smart Materials and Technology:** Structural health monitoring of buildings, bridges geotechnical and transportation structures, Different types of sensors their working and principles, Repairs and Rehabilitations, Modern Construction, Energy efficient Buildings- A case study.	**05**
		39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Explain the importance of the smart materials in Civil Engineering structures.
2. Describe the working principles of the smart materials.
3. Learn to select appropriate sensors.
4. Explain the smart concrete and its use in bridges
5. Explain the use of smart materials in the structural health monitoring.
6. Describe the sensing technology and select appropriate sensors for structural health monitoring.

Recommended Books:

1. D. Michelle Addington, Daniel L. Schodek, "Smart Materials and New Technologies For the architecture and design professions", Harvard University. ISBN0750662255.
2. Vinod K. Wadhawan, "Smart Structures: Blurring the Distinction between the Living and the Nonliving", Oxford University place, ISBN 978–0–19–922917–8.
3. Nilesh Y. Jadhav, Green and Smart Buildings Advanced Technology Options, Springer Nature, ISBN 978-981-10-1002-6.

4. Mel Schwartz, Encyclopaedia of Smart Materials, Vol. 1 and Vol. 2, John Wiley & Sons, Inc.
5. James Sinopoli, Advanced Technology for Smart Buildings, ARTECH HOUSE, Boston, London.
6. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
7. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.
8. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003.
9. Structural health monitoring of civil infrastructure Systems, Edited by Vistasp M. Karbhari and Farhad Ansari, CRC Press Boca Raton Boston New York Washington, DC, Woodhead Publishing Limited, New Delhi.
10. HuaPeng Chen and Yi-Qing Ni Structural Health Monitoring of Large Civil Engineering Structures, John Wiley & Sons Ltd, 2018.
11. SP-7 (National Building Code of India), Bureau of Indian Standards.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CEDLO8025	**Department Level Optional Course 6: Structural Dynamics**	**3**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorials	Theory	Practical	TW/Tutorials	Total
3	--	--	3	--	--	3

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IA-I	IA-II	Avg.						
20	20	20	80	3 Hr	--	--	--	100

Course Objective

- To expose the students to the basic theory of structural dynamics, structural behaviour under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.
- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete Two DOF systems,
- To study the modal analysis of Two DOF systems and analysis of systems with distributed mass for continuous system.

Detailed Syllabus

Module	Contents	Hrs
I	**Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.** Static vs. Dynamic loads. Different types of dynamics loads	4
II	**Introduction to single Degree of freedom (SDOF) Systems.** Undamped vibration of SDOF system natural frequency and period of vibration. Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor. Response of structure subjected to General dynamic load, Duhamel's Integral Numerical. Evaluation of Dynamics Response of SDOF system. Equivalent stiffness of spring in series and parallel.	8

III	**Introduction to Distributed mass system.** Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	4
IV	**Lumped mass multi-degree of freedom (Two DOF) system, coupled anduncoupled system** Direct determination of frequencies of vibration and mod shape. Orthogonality principle. Vibration of Two DOF systems with initial conditions Approximate method of determination of natural frequencies of vibration andmode shapes – Energy methods	9
V	**Earthquake analysis – Introduction.** Seismicity of a region, causes of earthquake Intensity of earthquake, Richter Scale, Measurement of Earthquake groundmotion, Seismogram, construction of seismograph Application of modal analysis concept to seismic disturbance, Introduction to Response spectrum method.	8
VI	**I.S code provisions for seismic analysis of buildings.** Approximate method of earthquake analysis– Seismic co-efficient methodand its limitation. Introduction to time history analysis.	6

Contributions to Outcomes

On completion of the course, the students will be able to

- Summarize the difference between static and dynamic loads and analysis.
- Evaluate the response of SDOF systems for different types of dynamic loadsincluding ground motions.
- Describe Distributed mass system idealized as SDOF system
- Evaluate the response of MDOF systems to different types of dynamic loadsincluding ground motions.
- Explain the basics of Concepts of Earthquake analysis.
- Describe the I.S code provisions for seismic analysis of buildings.

Theory Examination:

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this,the module shall be divided proportionately further, and the weightage of the marks shallbe judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Recommended Books:-

1. Craig R.R.: ‘Structural Dynamics-An Introduction to Computer Methods’, *John Wiley and Sons.*
2. Anil K. Chopra: ‘Dynamics of Structures’, *Prentice Hall India Pvt. Ltd.*
3. Cloguhand Penzein: ‘Dynamics of Structures’ *TataMc-Graw Hill Pvt. Ltd.*
4. John M. Biggs: ‘Structural Dynamics’, *Tata Mc-Graw Hill.*
5. Mario Paz: ‘Structural Dynamics Theory and Computation’, *CBS Publisher.*

Semester VIII

Course Code	Course Name	Credits
CEDLO8026	**Department Level Optional Course 6: Ground water Engineering**	03

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 hours	-	-	-	100

Rationale

This subject deals with the various processes involved in ground water Engineering which provides in depth understanding of the theories and concepts of hydrological parameters, well hydraulics, ground water quality etc. It also explains the concept of basin water management concept and its evaluation.

Objectives

1 To introduce the student to the principles of hydrological parameters
2 To Explain to the students the principles of Well Hydraulics.
3 To introduce the student the concept of ground water quality and conservation.
4 To introduce the student the concept of basin management

Detailed Syllabus

Module		Course Module / Contents	Hr
I		**Hydrogeological Parameters**	6
	1.1	Introduction – Water bearing Properties of Rock – Type of aquifers - Aquifer properties	
	1.2	permeability, specific yield, transmissivity and storage coefficient – Methods of Estimation	
	1.3	GEC norms - Steady state flow - Darcy's Law - Groundwater Velocity – Dupuit Forchheimer assumption	
	1.4	Steady Radial Flow into a Well	

II	**Well Hydraulics**		8
	2.1	Unsteady state flow - Theis method - Jacob method	
	2.2	Chow's method – Law of Times – Theis Recovery	
	2.3	Bailer method – Slug method - tests - Image well theory	
	2.4	Partial penetrations of wells – Well losses	
	2.5	Specific Capacity and Safe yield	
	2.6	Collector well and Infiltration gallery	
III	**Groundwater Management**		6
	3.1	Need for Management Model – Database for Groundwater Management – Groundwater	
	3.2	Balance study – Introduction to Mathematical model – Model Conceptualization	
	3.3	Initial and Boundary Condition – Calibration – Validation – Future Prediction – Sensitivity	
	3.4	Analysis – Uncertainty – Development of a model	
IV	**Groundwater Quality**		7
	4.1	Ground water chemistry - Origin, movement and quality - Water quality standards	
	4.2	Drinking water – Industrial water – Irrigation water	
	4.3	Ground water Pollution and legislation	
	4.4	Environmental Regulatory requirements	
V	**Groundwater Conservation**		5
	5.1	Artificial recharge techniques – Reclaimed wastewater recharge – Soil aquifer treatment (SAT)	
	5.2	Aquifer Storage and Recovery (ASR)Seawater Intrusion and Remediation	
	5.3	Ground water Basin management and Conjunctive use	
	5.4	Protection zone delineation, Contamination source inventory and remediation schemes Name of Module 6 Management of Groundwater	
VI	6.1	Concept of basin management	7
	6.2	Ground water basin investigations	
	6.3	Basin management and conjunctive use	
	6.4	Basin yields	

Contribution to Outcome

On completion of this course, the students will be able to:

1 Apply the principals of hydrological parameters for design of wells.
2 Calculate the specific yield and yield of well under different ground water conditions.
3 Develop a model for groundwater management.
4 Explain the concept of ground water quality models

Internal Assessment **20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination **80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1 Question paper will comprise of total six questions, each carrying 20 marks.

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Numerical Ground Water Hydrology: A.K. Rastogi, Penram International Publishing, Mumbai,2007

2 Ground Wter Hydrology: D.K.Todd, John Wiley &Sons, New York, USA, 1980

3 Ground water Hydrology by A. K. Rastogi

4 Hydrology- Principles, Analysis, Design: H.M.Raghunath, New Age International Publishers.

5 Engineering Hydrology: C.S.P.Ojha, R.Berndtsson, &P.Bhunya:, Oxford University Press

Reference Books:

1 Fitts R Charles, "Groundwater Science". Elsevier, Academic Press, 2002.

2 Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998

Semester VIII		
Subject Code	**Subject Name**	**Credits**
ILOC8011	**Institute Level Optional Course – II : Project Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Module	Detailed Contents	Hrs
I	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
II	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
III	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
IV	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.	6

	Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
V	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	**8**
VI	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	**6**

Outcomes

Students will be able to :

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 questions

- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Semester VIII		
Course Code	Course Name	Credits
ILOC8012	Institute Level Optional Course – II : Finance Management	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Module	Detailed Contents	Hrs
I	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
II	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
III	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios;	09

	Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
IV	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10**
V	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**05**
VI	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Outcomes

Students will be able to…

- Describe Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8013	**Institute Level Optional Course – II : Entrepreneurship Development and Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Module	Detailed Contents	Hrs
I	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
II	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
III	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	05
IV	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships,	08

	National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
V	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	**08**
VI	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	**05**

Outcomes:

Students will be able to…

- Explain the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Describe government policies for entrepreneurs

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship-,Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8014	**Institute Level Optional Course – II : Human Resource Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Module	Detailed Contents	Hrs
I	**Introduction to HR** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
II	**Organizational Behavior (OB)** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7
III	**Organizational Structure &Design** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	6

	Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
IV	**Human resource Planning** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
V	**Emerging Trends in HR** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
VI	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labour Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Contribution to Outcomes:

Students will be able to:

- Explain the concepts, aspects, techniques and practices of the human resource management.
- Describe the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks

2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8015	**Institute Level Optional Course – II : Professional Ethics and CSR**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Module	Detailed Contents	Hrs
I	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
II	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
III	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
IV	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
V	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)	08
VI	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Contribution to outcomes

Students will be able to…

- Summarize rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Explain legal aspects of corporate social responsibility

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. **Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.**

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8016	**Institute Level Optional Course – II : Research Methodology**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Module	**Detailed Contents**	**Hrs**
I	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**09**
II	**Types of Research** **2.1.** Basic Research **2.2.** Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5.** Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
III	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
IV	**Research Methodology** **4.1** Meaning of Research Methodology	**08**

	4.2. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
V	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
VI	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Course Outcomes

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education.

SemesterVIII		
Course Code	**Course Name**	**Credits**
ILOC8017	**Institute Level Optional Course – II : IPR & Patenting**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Module	**Detailed Contents**	**Hr**
I	**Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
II	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
III	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
IV	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07

V	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
VI	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Outcomes:

Students will be able to…

- Explain Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian,2012,Intellectual Property Rights, 1st Edition,Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial

Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8018	**Institute Level Optional Course – II : Digital Business Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Module	Detailed content	Hrs
I	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts ference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
II	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement . B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
III	**Digital Business Support services:** ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
IV	**Managing E-Business-**Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce	06

	Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
V	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
VI	**Caterializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Outcomes:

Students will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Semester VIII		
Course Code	**Course Name**	**Credits**
ILOC8019	**Institute Level Optional Course – II : Environmental Management**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			**Total Marks**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Module	**Detailed Contents**	**Hrs**
I	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
II	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
III	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
IV	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
V	Total Quality Environmental Management, ISO-14000, EMS certification.	05
VI	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Contribution to Outcomes

Students will be able to…

- Describe the concept of environmental management
- Evaluate ecosystem and interdependence, food chain etc.
- Compare and interpret environment related legislations

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Semester-VIII

Course Code	Course Name	Credits
CEL801	Construction Management	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	02	-		01	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	–	25	50

Course Objective:

1 To understand the basic functions and construction management.

2 To apply scheduling techniques such as CPM & PERT

3 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.

4 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.

5 To know about safety and quality aspect of construction works.

Course Outcomes:

At the end of the course, learner will be able to:

1 Summarize & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.

2 Prepare feasible project schedule by using various scheduling techniques.

3 Gain knowledge of managing various resources & recommend best method of allocating resources to the project.

4 Develop optimum relationship between time & cost for construction project.

5 Implement quality & safety measures on construction sites during execution of Civil Engineering projects.

6 Explain the importance of labour acts.

List of Assignments

Module No.	Assignment	Tutorial Hr.
1	**Assignment No. 1:** Principles, Functions, and contribution eminent personalities towards Management	02
2	**Assignment No.2**: Project classifications, Unique features of construction, Various agencies involved in construction industry	02
3	**Assignment No.3**: Bar Charts its limitations and its uses Numerical on development of networks and calculation of floats using CPM technique.	02
4	**Assignment No.4:** Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project.	02
5	**Assignment No.5**: Numerical on Resources Allocation Methods-Resource levelling and Smoothening	02
6	**Assignment No.6**: Procedure and Numerical on Time and cost optimization in construction projects - Compression & decompression of network.	02
7	**Assignment No.7**: Network Updating- Purpose and frequency of updating. Numerical on Project Updating	02
8	**Assignment No.8**: Construction Safety, Quality Control & Labour Acts	02

Term Work

Comprises of Assignments, which has to be submitted by each student individually.

Distribution of marks for Term Work shall be as follows:

Assignments: 20 Marks
Attendance : 05 Marks

Further, while giving **weightage of marks on the attendance, following guidelines shall be resorted to.**

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

End Semester Oral Examination: The oral examination shall be based on the entire syllabus & the Term-work prepared by the students including assignments.

Reference Books:

1 Construction Engineering and Management: S. Seetharaman.
2 Construction Planning & Management – Dr. U. K. Shrivastava.
3 Construction Project Management: Chitkara K. K. Tata McGraw Hill.
4 Construction Projects planning and Management: P. S. Gahlot and Dhir New Age International (p) Publishers
5 Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley
6 Construction Hazard and Safety Handbook: King &Hudson, Butterworth

<table>
<tr><th colspan="9">Semester - VIII</th></tr>
<tr><td colspan="2">Course Code</td><td colspan="6">Course Name</td><td>Credits</td></tr>
<tr><td colspan="2">CEP801</td><td colspan="6">Major Project- Part II</td><td>06</td></tr>
<tr><td colspan="3">Contact Hours</td><td colspan="6">Credits Assigned</td></tr>
<tr><td>Theory</td><td>Practical</td><td>Tutorial</td><td colspan="2">Theory</td><td>Practical</td><td colspan="2">Tutorial</td><td>Total</td></tr>
<tr><td>-</td><td>12$</td><td>-</td><td colspan="2">-</td><td>6</td><td colspan="2">-</td><td>6</td></tr>
<tr><td colspan="5">Theory</td><td colspan="3">Term Work/Practical/Oral</td><td rowspan="3">Total</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td><td rowspan="2">Duration of End Sem Exam</td><td rowspan="2">TW</td><td rowspan="2">PR</td><td rowspan="2">OR</td></tr>
<tr><td>Test–I</td><td>Test–II</td><td>Average</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>50</td><td>-</td><td>100</td><td>150</td></tr>
</table>

Rationale

In the field of Civil Engineering, new problems arise every now and then; but a professional civil engineer must know how to precisely identify & state those problems, define the scope & objectives of the probable solution(s), carry out effective review of available literature in the domain of the problem and formulate a systematic methodology to solve the problem. Modern tools and multidisciplinary knowledge are vastly used nowadays for the effective solution of civil engineering problem. It is also important to work effectively & ethically as a team and communicate the work done in the form of written reports. The aim of this course is to acquaint the learners with all of the above-mentioned aspects of the civil engineering field by inculcating the process of research

Objectives

1. To acquaint the learners to analyse the problem.
2. To accustom the learners to apply various techniques and methods.
3. To familiarize the learners about interpreting the results and discuss the issues.
4. To advice the learners to write and infer conclusions of the project.
5. To accustom the learners to work as a team.
6. To apprize the learners on proper documentation of work.

Detailed Syllabus

After completion of the work at the end of Semester VIII, the student shall compile the report in a standard format and written in the systematic manner and chapter wise.

The student shall adhere to the following scheme of chapterization while compiling the final report in general. The Guide/ Supervisor shall ensure the student has written the Dissertation Report in appropriate language (grammatically correct).

Contribution to Outcomes

On completion of this course, the students will be able to:

1: Perform on analytical, experimental or numerical method to solve identified problem
2: Produce alternative design solution to meet the functional requirements of the defined problem.
3: Represent the data in Tabular or graphical forms so as to facilitate, analysis & explain of the data.
4: Express Engineering principles & manage the finance required for the execution of the Project.
5: Infer at results, conclusion with its validation, also propose the future scope of work on the identified problem.
6: Communicate effectively their project work by writing reports and publishing technical papers based on entire project work.

Guidelines for Assessment of Project II
Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai

Students should be motivated to publish a paper in Conferences/students competitions based on the work

R16 , E

Again Uploaded Syll. as per AAMS section e-mail, dt. 23.3.2021

AC. 11/5/2017

Item No. 4.177

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering (Second Year – Sem. III & IV)

Revised course (REV – 2016)

With Effect From Academic Year 2017 – 18

Under the

FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC. 11/5/2017

Item No. 4.177

UNIVERSITY OF MUMBAI

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Civil Engineering (Second Year – Sem. III & IV)

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FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

Preface

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, semester based credit grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for First Year of Engineering from the academic year 2016 – 2017. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2017 – 2018, for Third Year and Final Year Engineering in the academic years 2018 – 2019, 2019 – 2020, respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education reflects the fact that in achieving recognition, the institution or program of study is committed open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I am happy to state here that, Program Educational Objectives were finalized in a meeting where syllabus committee members were also present. The Program Educational Objectives finalized for undergraduate program in civil Engineering are as follows:

1. To prepare Learner's with a sound foundation in the mathematical, scientific engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To prepare Learner's for successful career in Indian Multinational Organisations to excel in Postgraduate studies
4. To encourage motivate Learner's for self-learning
5. To inculcate professional ethical attitude, good leadership qualities commitment to social responsibilities in the Learner's

In addition to above each institute is free to add few (2 to 3) more Program Educational Objectives of their own. In addition to Program Educational Objectives, course objectives expected course outcomes from learner's point of view are also included in the curriculum for each course of undergraduate program to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. S. K. Ukarande
Chairman, Board of studies in Civil Engineering
University of Mumbai, Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai
Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai
Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		19	16		19	8	-	27

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (In Hrs.)				
		Test 1	Test 2	Avg						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		--	--	120	480	--	200	--	150	950

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course 'Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course 'Business and Communication Ethics (CE-C 507)' will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying CE-DLO5062: Advanced Concrete Technology CE-DLO5063: Building Services and Repairs CE-DLO5064: Advanced Structural Mechanics	CE-DLO6061: Advanced Construction Equipment CE-DLO6062: Traffic Engineering and Management CE-DLO6063: Ground Improvement Techniques CE-DLO6064: Advanced Structural Analysis

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	--	2	4		2	6
CE-C703	Water Resource Engineering -II	3	--	2	3	--	2	5
CE-DLO704X	Department Level Optional Course-III	3	--	2	3	--	2	5
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**8**	**6**	**17**	**4**	**6**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 705), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	2	--	4	1	-	5
CE-C802	Construction Management	4	2	--	4	1	-	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	--	3	--	--	3
CE-P804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**18**	**-**	**15**	**9**	**-**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	--	--	--	100
CE-P804	Project – Part II	--	--	--			50	--	50[#]	100
Total		**80**	**80**	**80**	**320**		**125**		**125**	**650**

[#] The oral examination for the Project- Part II (CE-P 804) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.

(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.

(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete	CE-DLO8031: Advanced Design of Steel Structures
CE-DLO7042: Solid Waste management	CE-DLO8032: Industrial Waste Treatment
CE-DLO7043: Pavement Sub-grade and Materials	CE-DLO8033: Pavement Design and Construction
CE-DLO7044: Structural Dynamics	CE-DLO8034: Bridge Engineering and Design
CE-DLO7045: Application of GIS and Remote Sensing	CE-DLO8035: Appraisal and Implementation of Infrastructure Projects
CE-DLO7046: Foundation Analysis and Design	CE-DLO8036: Soil Dynamics
	CE-DLO8037: Applied Hydrology and Flood Control

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management	ILO8021: Project Management
ILO7012: Reliability Engineering	ILO8022: Finance Management
ILO7013: Management Information Systems	ILO8023: Entrepreneurship Development and Management
ILO7014: Design of Experiments	ILO8024: Human Resources Management
ILO7015: Operations Research	ILO8025: Professional Ethics and Corporate Social Responsibility (CSR)
ILO7016: Cyber Security and Laws	ILO8026: Research Methodology
ILO7017: Disaster Management and Mitigation Measures	ILO8027: Intellectual Property Rights and Patenting
ILO7018: Energy Audit and Management	ILO8028: Digital Business Management
ILO7019: Development Engineering	ILO8029: Environment Management

Semester III

	Semester III	
Subject Code	**Subject Name**	**Credits**
CE-C 301	Applied Mathematics–III	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
- To study the basic principles of Laplace Transform, Fourier Series, Complex variables

Details Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Laplace Transform**		12
	1.1	Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$	

	1.2	Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform of Periodic functions	
	1.3	Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem (without proof).	
	1.4	Applications to solve initial and boundary value problems involving ordinary Differential equations with one dependent variable.	
II.	**2. Complex variables**		**08**
	2.1	Functions of complex variable, Analytic function, necessary and sufficient conditions for to be analytic (without proof), Cauchy-Riemann equations in polar coordinates.	
	2.2	Milne-Thomson method to determine analytic function when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories.	
	2.3	Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation.	
III.	**3. Complex Integration**		**08**
	3.1	Line integral of a function of a complex variable, Cauchy's theorem for analytic functions (without proof) Cauchy's integral formula (without proof) Singularities and poles:	
	3.2	Taylor's and Laurent's series development (without proof)	
	3.3	Residue at isolated singularity and its evaluation.	
	3.4	Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$, & $\int_{-\infty}^{\infty} f(x)\, dx$	
IV.	**4. Fourier Series**		**10**
	4.1	Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π & $2l$.	
	4.2	Dirichlet's theorem (only statement), even and odd functions, Half range sine and cosine series, Parsvel's identities (without proof)	

	4.3	Complex form of Fourier series.	
V.	**5. Partial Differential Equations**		**09**
	5.1	Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method).	
	5.2	Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series.	
	5.3	Heat equation, steady-state configuration for heat flow.	
	5.4	Two and Three dimensional Laplace equations.	
VI.	**6. Correlation and Curve Fitting.**		**05**
	6.1	Correlation-Karl Pearson's coefficient of correlation- problems. Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems	
	6.2	Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$.	
		Total	**52**

Contribution to Outcomes

After completion of the course, students will be able to..

- Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations.
- Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations.
- Solve initial and boundary value problems involving ordinary differential equations.
- Identify the analytic function, harmonic function, orthogonal trajectories.
- Apply bilinear transformations and conformal mappings.
- Identify the applicability of theorems and evaluate the contour integrals.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus and may before this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to complete at least 8 class tutorials on entire syllabus.

Recommended Books:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication

2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited

3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi

4. Complex Variables: Churchill, Mc-Graw Hill

5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai

6. Numerical Methods, Kandasamy, S. Chand & CO

7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 302	Surveying–I	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Surveying is a core subject for civil engineers. It is the first step towards all civil engineering projects. A good surveyor is an asset to the company, organization or establishment. All the civil engineering projects such as buildings, transportation systems including roads, bridges, railways, airports along with dams and water/ sewage treatment plants start with surveying as the basic operations. Hence, the knowledge of surveying is very essential to all the civil engineering professionals. In this subject, the students get acquainted with the basic methods and instruments that are used in surveying and it helps them to produce plans and sections. It is also useful in setting out civil engineering structures on construction sites.

Objectives

- To understand appropriate methods of surveying based on accuracy and precision required availability of resources, economics and duration of project.
- To study techniques for measurement of distance, setting offsets, calculate area and volume using surveying instruments
- To study the functions of various instruments, their least counts, possible errors, advantages and limitations.
- To study various techniques for solving Surveying related problems.
- To study the superiority and leverage of using modern methods in surveying over conventional ones.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Introduction**		08
	1.1	Definition, principles, objectives, classification, technical terms, uses and necessity of surveying. Units of measurement, surveying measurement and errors, type of errors and their corrections (including numericals), corrections for wrong scales, accuracy and precision, stages of survey operations	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Types, Instruments required, methods, obstacles (including numericals), sources of errors, conventional signs and symbols.	
	1.3	Electronic Distance Measurement: Working Principles, types, applications in surveying	
II.	**Measurement of Directions and Angles**		10
	2.1	Basic definitions, meridians, bearings, magnetic and true bearings, compasses, prismatic and surveyor's, temporary adjustments, declination, dip, local attraction	
	2.2	Types of traverse, procedures, control establishments, Conversion of WCB into RB and vice-versa, Traverse Survey and Computations of interior angles of a closed Traverse. Adjustment of closing error, correction for local attraction.	
III.	**Levelling and its application**		12
	3.1	Introduction to levelling, basic terms and definitions, types of instruments, construction and use of dumpy level, auto level, digital level and laser level in construction industry, principle axes of dumpy level, temporary and permanent adjustments	
	3.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon, corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	3.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors, difficulties in levelling work, corrections and precautions in levelling work.	

IV.	**Plane Tabling, Contouring, Area and Volume**		**08**
	4.1	**Plane Table Surveying:** Definition, principles, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying, Errors in plane table surveying, Use of telescopic alidade	
	4.2	**Contouring**: definitions, contour interval, equivalent, uses and characteristics of contour lines, direct and indirect methods of contouring. Grade contour: definition and use.	
	4.3	**Area**: Area of an irregular figure by trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods. Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	4.4	**Volume**: Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plans	
V.	**Theodolite Traversing**		**10**
	5.1	Various parts and axis of transit, technical terms, temporary and permanent adjustments of a transit, horizontal and vertical angles, methods of repetition and reiteration.	
	5.2	Different methods of running a theodolite traverse, Latitudes and departures, rectangular coordinates, traverse adjustments by Bowditch's, transit and modified transit rules, Gales Traverse Table, Numerical Problems	
	5.3	Use of theodolite for various works such as prolongation of a straight line, setting out an angle, bearing measurements. Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing; Trigonometrical Levelling: Problems on one plane and two plane methods,	
VI.	**Tacheometric surveying**		**06**
	6.1	Principle, purpose, uses, advantages and suitability of tacheometry, different methods of tacheometry, stadia formula, Stadia diagram and tables. Sub-tense bar method	
	6.2	Application in plane table and curve setting.	
	6.3	Radial Contouring	
		Total	**52**

Contribution to Outcomes

On completion of the course, the learners will be able to:

- Apply principles of surveying and leveling for civil engineering works
- Measure vertical and horizontal plane, linear and angular dimensions to arrive at solutions to basic surveying problems.
- Perform various practical and hence projects using different surveying instruments.
- Apply geometric principles for computing data and drawing plans and sections
- Analyze the obtained spatial data and compute areas and volumes and represent 3D data on plane surfaces (2D) as contours

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination will be conducted in conjunction with the practical/s and will be based on the entire syllabus and the term work. The weightage of the practical examination will be of 10 marks and that of oral, 15 marks.

List of Practical:

1. Computing area of polygon by chaining, ranging and offsetting and verify distances by EDM
2. Measuring bearing of closed traverse using Prismatic/Surveyor's compass and computing included angle.
3. Simple and differential levelling using dumpy level
4. Transferring R.L from benchmark to new point by auto level/digital level with at least three change points and performing check levelling
5. Measurement of horizontal angle by Repetition and Reiteration Method using Vernier Transit theodolite.
6. To find the constants of a tachometer and to verify filed distances.
7. To find R.L and distances by tachometric surveying.

8. To find height of inaccessible tower using one plane and two plane methods using Vernier Transit theodolite.
9. Plane table surveying by various methods with at least four stations.
10. Determination of areas of irregular figures by conventional/digital planimeter

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work:

It shall consist of the following:

- Field book based on afore-mentioned practicals conducted on and off the field.
- The account of practical performed with aim, apparatus, observations, calculations, results and inferences.
- The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus : 10 marks
Practical : 10 marks
Attendance (Theory and Practical) : 05 marks
Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Surveying and Leveling: Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
2. Surveying and Levelling: *N.N.Basak*, Tata McGraw Hill, New Delhi.
3. Surveying: *R. Agor*, Khanna Publishers.

4. Surveying: Vol-I: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling (2nd Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling (Vol.-I): *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling (Vol.-I): *S.K. Duggal*, Tata Mc-Graw Hill
8. Textbook of Surveying, By *C Venkatramaiah*, University Press, Hyderabad, Latest Edition

Web Materials:

1. http://nptel.ac.in/courses/105107122/

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 303	Strength of Materials	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

There are different types of structures made up of different materials such as concrete, steel, metals and timber. They are subjected to various types of loading/ forces such as axial, shear, bending and torsion. This subject equips the students to analyze the internal behavior of material of the structural members under different types of loading. The knowledge gained in this subject is helpful to study other subjects like Structural Analysis and Structural Design.

Objectives

- To study the engineering properties of the materials and solids and analyze the same to evaluate the stress –strain behaviour.
- To analyze the internal forces for the statistically determinate and compound beams having internal hinges with different types of loading.
- To understand the concept and behaviour of flexural members (beams) in flexure and shear, solid circular shaft for torsion, thin shells for internal stresses.
- To introduce the concept of strain energy for axial, flexure, shear and torsion.
- To study the behaviour of axially loaded columns and struts using different theories available for the analysis with various end conditions.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**1. Simple Stresses and Strains**		08
	1.1	Stresses, Strains, Modulus of elasticity (E), Modulus of rigidity (G), Bulk Modulus (K), Yield Stresses, Ultimate Stress, Factor of safety, shear stress, Poisson's ratio.	
	1.2	Relationship between E, G and K, bars of varying sections, deformation due to self- weight, composite sections, temperature stress.	
II.	**2. Shear Force and Bending Moment in Beams**		06
	2.1	Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading.	
	2.2	Relationship between rate of loading, shear force and bending moment.	
III.	**3. 1 Theory of Simple Bending**		07
	3.1.1	Moment of inertia, transfer theorem, polar moment of inertia	
	3.1.2	Flexure formula for straight beam, simple problems involving application of flexure formula, section modulus, moment of resistance, flitched beams.	
	3.2Strain Energy		03
	Strain energy due to axial force, stresses in axial member and simple beams under impact loading.		
IV.	**4.1. Shear Stresses in Beams**		06
	Distribution of shear stress across plane sections commonly used for structural purposes.		
	4.2 Theory of Simple Torsion		06
	4.2.1	Torsion in circular shafts-solid and hallow, stresses in shaft when transmitting power	
	4.2.2	Concept of equivalent torsional and bending moment	
V.	**5.1 Direct and Bending Stresses**		05
	Application to member's subjected to eccentric loads, core of section, problems on chimneys, retaining walls, dams, etc. involving lateral loads.		
	5.2 Columns and Struts		04
	Members subjected to axial loading, concept of buckling, Effective length, Euler's formula for columns and struts with different support conditions, Limitation of		

	Euler's formula, Rankine's formula, Problems based on Euler's and Rankine's formulae.	
VI.	**6.1 Principal Planes and Stresses**	**04**
	General equation for transformation of stress, principal planes and principal stresses, maximum shear stress, stress determination using Mohr's circle.	
	6.2 Thin Cylindrical and Spherical Shells	**03**
	Thin Cylindrical and spherical shells under internal pressure.	
	Total	**52**

Contribution to Outcomes

On completion of the course, the students will be able to:

- Understand and determine the engineering properties for metals and non-metals.
- Understand the concepts of shear force, bending moment, axial force for statically determinate beams and compound beams having internal hinges; and subsequently, its application to draw the shear force, bending moment and axial force diagrams.
- Analyze the flexural members for its structural behavior under the effect of flexure (bending), shear and torsion either independently or in combination thereof.
- Study the behavior of the structural member under the action of axial load, bending and twisting moment.
- Study the deformation behavior of axially loaded columns having different end conditions and further, evaluate the strength of such columns.

The successful completion of the course will equip the students for undertaking the courses dealing with the analysis and design of determinate and indeterminate structures.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an internal choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt anythree questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and the report of the experiments/ practicals conducted by the students including assignments.

List of Practicals:

1. Tension test on mild steel bars (stress-strain behavior, Young's modulus determination)
2. Tests on Tor Steel (Tension, bend and re-bend)
3. Transverse Test on cast iron.
4. Shear Test on mild steel, cast iron, and brass.
5. Torsion Test on mild steel and cast iron bar.
6. Brinell Hardness test (any three metal specimen)
7. Rockwell Hardness test on mild steel.
8. Izod / Charpy impact test (any three metal specimen)

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 Marks
Assignments : 10 Marks
Attendance : 05 Marks
Total : 25 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and JaanKiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and NillanjanMallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 304	Engineering Geology	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Geology is the study of earth, the minerals and rocks of which it is made. The study of the structures presents in the rocks and the effects of the natural forces acting upon them is essential to understand by civil engineers because all work performed by them involves earth and its features. The study helps to understand the causes and prevention of many geological activities like earthquakes, landslides and volcano. For a civil engineering project like dams, bridges, buildings etc. to be successful the engineers must understand the foundation rock and their structures, it also helps them to examine rocks for important metals, oil, natural gas and ground water.

Objective

- To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
- To study of 'Theory of Plate Tectonics' which helps to explain much of the global-scale geology including the formation of mountains, oceans, different landforms and the occurrence and distribution of earthquakes, volcanoes, landslides etc.
- To study minerals and rocks in detail in order to understand their origin, texture, structure and classification which is helpful to comment on suitability of rock type for any civil engineering project
- To study structural geology in order to understand deformational structures like fold, fault, joint, etc. and the forces responsible for their formation.
- To study methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.

- To study ground water zones, factors controlling water bearing capacity of rocks, geological work of ground water and techniques of recharge of groundwater.

Detailed Syllabus

Module	Sub-Modules/Contents		Periods
I.	**Introduction**		6
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth, Theory of Plate Tectonics.	
	1.3	Agents modifying the earth's surface, study of weathering and its significance in engineering properties of rocks like strength, water tightness and durability etc.	
	1.4	Brief study of geological action of river, wind, glacier, ground water and the related land forms created by them.	
	1.5	Building stones- Requirements of good building stones and its geological factors, controlling properties, consideration of common rocks as building stones, study of different building stones from various formations of Indian Peninsula.	
II.	**Mineralogy and Petrology**		7
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, Classifications, study of commonly occurring igneous rocks and their engineering application.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., residual deposits, chemically and organically formed deposits, classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, metamorphic minerals, rock cleavage, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	

III.	**Structural Geology, Stratigraphy and Indian Geology**		7
	3.1	Structural elements of rocks, dip, strike, outcrop patterns, outliers and inliers, study of joints, unconformities and their engineering consideration. Faults and folds, their classification and importance in engineering operations.	
	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province	
IV.	**Geological Investigation, study of dam and reservoir site:**		7
	4.1	Preliminary Geological Investigation and their importance to achieve safety and economy of the projects like dams and tunnels, methods of surface and subsurface investigations, Excavations-Trial pit, trenches etc.	
	4.2	Core Drilling - Geological logging, Inclined Drill holes. Electrical Resistivity method, Seismic method and their applications	
	4.3	Strengths, stability, water tightness of the foundation rocks and its physical characters against geological structures at dam sites, favourable and unfavourable geological conditions for locating dam sites.	
	4.4	Precautions over the unfavourable geological structures like faults,dykes, joints, unfavourable dips on dam sites and giving treatments, structural and erosional valleys.	
V.	**Tunnel Investigation and Ground Water Control**		7
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions, Difficulties during tunneling and methods to overcome the difficulties. Methods of tunneling in soft soil	
	5.2	Sources, zones, water table, unconfined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Cone of depression and its use in Civil engineering. Artesian well (flowing and non-flowing)	
	5.3	Springs seepage sites and geological structures. Different types of rocks as source of ground water	
	5.4	Methods of artificial recharge of ground water, geology of percolation tank.	
VI.	**Geological Disasters and Control Measures**		5
	6.1	**Landslides-** Types, causes and preventive measures for landslides, Landslides in Deccan region	

	6.2	**Volcano-** Central type and fissure type, products of volcano and volcanic land forms.	
	6.3	**Earthquake-** Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory Preventive measures for structures constructed in Earthquake prone areas.	
		Total	**39**

Contribution to Outcomes

On completion of the course, the students shall be able to:

- Understand the significance of geological studies for safe, stable and economic design of any civil engineering structure.
- Demonstrate the knowledge of geology to explain major geological processes such as formation of mountain, ocean and the occurrence and distribution of earthquakes and volcanoes.
- Explain various geological structures like folds, faults, joints, unconformity, their origin and distribution which are very essential in the design and construction of dams, tunnels and any other major civil engineering project.
- Understand methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.
- Understand the causes and prevention of natural hazard like earthquake, landslide, volcano etc. will help student to meet the specific needs with suitable considerations for public health and safety.
- Prepare effective reports mentioning advantages and disadvantages caused due to geological condition and can evaluate any site for civil engineering project.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

Oral examination will be based on the entire syllabus and a neatly written report for the practical along with a report of the site visit.

List of Practicals:

1. Study of physical properties of the minerals.
2. Identification of minerals- Quartz and its varieties, Orthoclase, Plagioclase, Muscovite, Biotite, Hornblende, Asbestos, Augite, Olivine, Tourmaline, Garnet, Actinolite, Calcite, Dolomite, Gypsum, Beryl, Bauxite, Graphite, Galena, Pyrite. Hematite, Magnetite, Chromite, Corundum, Talc, Fluorite, Kyanite.
3. Identification of rocks: ***Igneous rocks***-Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic tuffs. ***Sedimentary Rocks-*** Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites. ***Metamorphic Rocks-*** Mica Schists, Hornblende Schists, Slate, Phyllite, Granite Gneiss, Augen gneiss, Marbles and Quartzite.
4. Study of Geological maps (At least 5).
5. Study of core samples, RQD, Core logging.
6. At least two engineering problems based on field data collected during site investigation.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term work shall consist of the:

1. Report of the practical conducted in terms of the study of the physical properties of the minerals, identification of minerals and rocks.
2. Report of the Geological maps.
3. Report of the two problems based on field data.
4. At least *six* assignments covering entire syllabus

Site Visit:

There shall be a visit to get the geological information according to the various contents mentioned in the syllabus. The students shall prepare a detail report along with the summarized findings. The report will form a part of the term work.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 marks
Assignments	:	07marks
Site Visit Report	:	03 marks
Attendance	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75% – 80%: 03 Marks; 81% – 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Text book of Engineering Geology: *Dr. R. B. Gupte*, Pune VidyarthiGrihaPrakashan,Pune.
2. Text book of Engineering Geology: *P. K. Mukerjee*, Asia.
3. Text book of Engineering and General Geology: *Parbin Singh*, Carson Publication.
4. Text book of Engineering Geology: *N. Chenna, Kesavulu*, Mc-Millan.
5. Principles of Engineering Geology: *K. M. Banger*.

Reference Books:

1. Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
2. Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
1. Principles of Geomorphology: *William D. Thornbury*, John Wiley Publications, New York.
2. Geology for Civil Engineering: A. *C. McLean, C.D. Gribble, George Allen &Unwin*London.
3. Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 305	Fluid Mechanics–I	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science of fluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics with their applications in fluid flow problems.

Course Objectives

Students are introduced to:

- Properties of fluids and basic concepts applicable to fluid mechanics and its relevance in civil engineering.
- Fundamentals of hydrostatics viz. Pascal's law, hydrostatic law and determination of hydrostatic pressure and centre of pressure of surfaces.
- Principle of buoyancy and its application
- The concept of fluid kinematics and ideal fluid flow.
- Concepts of control volume, control surface and dynamics of fluid flow.
- Various flow measuring devices and their applications

Detailed Syllabus

Module	Sub-Module / Contents		Periods
I.	**1. Properties of Fluids**		03
	Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, basic concepts applicable to fluid mechanics		
II.	**2. Fluid Statics**		10
	2.1	**Pressure measurement:** Pascal's law, hydrostatic law, pressure variation in fluids at rest. Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	**Hydrostatic force on surfaces:** Total pressure and centre of pressure, total pressure on horizontal plane surface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	**Buoyancy and flotation:** Archimedes principle, Meta-centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
III.	3. **Liquids in Relative equilibrium & Fluid Kinematics**		08
	3.1	**Liquids in Relative equilibrium** Fluid mass subjected to uniform linear acceleration, liquid containers subjected to constant horizontal acceleration and vertical acceleration, fluid containers subjected to constant rotation with axis vertical and horizontal.	
	3.2	**Fluid Kinematics** Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, velocity potential and stream function, streamline, streak line, path line, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity.	
IV.	**4. Introduction to Ideal flow.**		04
	Introduction to ideal fluid flow, uniform flow, source and Sink, free vortex flow, superimposed flow, doublet, Flow past a half body, flow past a Rankine oval body and flow past a cylinder		

V.	**5. Fluid dynamics**		06
	Control volume and control surface, Forces acting on fluid in motion, NavierStokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, rotameter.		
VI.	**6. Flow measurement**		08
	6.1	**Orifices and Mouthpieces:** Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	6.2	**Notches and Weirs:** Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolleti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
		Total	**39**

Contribution to Outcomes

On completion of this course the student will be able to:

- Define various properties of fluids, state and explain different types of laws and principles of fluid mechanics.
- Interpret different forms of pressure measurement and Calculate Hydrostatic Force and its Location for a given geometry and orientation of plane surface.
- Compute force of buoyancy on a partially or fully submerged body and analyse the stability of a floating body.
- Distinguish velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
- Derive Euler's Equation of motion and Deduce Bernoulli's equation.
- Measure velocity and rate of flow using various devices.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

List of Experiments (Any six):

1. Determination of metacentric height.
2. Verification of Bernoulli's theorem.
3. Determination of coefficient of discharge through Venturimeter.
4. Determination of coefficient of discharge through Orifice meter.
5. Determination of coefficient of discharge through Nozzle meter.
7. Determination of coefficient of discharge through Notches (Rectangular and Triangular notch).
8. Determination of coefficient of discharge over weirs (Broad Crested weir and Ogee weir).
9. Determination of hydraulic coefficients of orifice.
10. Determination of coefficient of discharge through mouthpiece.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments : 10 Marks
Assignments : 10 Marks
Attendance : 05 Marks
Total : 25 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% – 80%: 03 Marks; 81% – 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr. P.M. Modi and Dr. S.M. Seth*, Standard Book House, Delhi
3. Theory and Application of Fluid Mechanics: *K. Subramanian*, Tata McGraw hill publishing company, New Delhi.
4. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
5. Fluid Mechanics and Hydraulics: *Dr. S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar*, F.K. Kataria and sons
7. Fluid Mechanics: *R.K. Bansal,*Laxmi Publications (P) Ltd.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications: *R.L. Daugherty, J.B. Franzini, E.J. Finnemore*, Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: *Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer*. Oxford Higher Education.

Semester IV

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 401	Applied Mathematics–IV	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To inculcate an ability to relate engineering problems to mathematical context
- To provide a solid foundation in mathematical fundamentals required to solve engineering problem
- To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
- To prepare students for competitive exams

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Matrices**		**08**
	1.1	Brief revision of vectors over a real field, inner product, norm of a vector	
	1.2	Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof). Similarity of matrices. Functions of a square matrix	
II.	**2. Matrices**		**09**
	2.1	Minimal polynomial and Derogatory matrix.	
	2.2	Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors	
	2.3	**Vector calculus** Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function.	
	2.4	Line integrals, circulation of a vector, condition for independence of the path in the line integral.	
III.	**3. Vector calculus**		**09**
	3.1	Green's theorem (without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions. (No verification problems on Stoke's Theorem and Gauss Divergence Theorem), Linear Programming problems.	
	3.2	Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P.	
IV.	**4. Linear Programming Problems Probability Distributions**		**09**
	4.1	Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P., Probability Distributions	
	4.2	Discrete and Continuous random variables, Probability mass and density	

		function, Probability distribution for random variables, Expected value, Variance.	
	4.3	Probability Distributions: Binomial, Poisson and Normal Distributions.	
V.	**5. Sampling theory**		**09**
	5.1	Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples.	
	5.2	Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples.	
	5.3	Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	
VI.	**6. Sampling theory and ANOVA**		**08**
	6.1	Chi-square test, Test for the Goodness of fit, Association of attributes and Yate's correction	
	6.2	Analysis of Variance(F-Test): One-way classification, Two-way classification (short-cut method)	
		Total	**52**

Contribution to Outcomes

After learning the topics, the students will be able to:

- Solve the system of linear equations using matrix algebra with its specific rules
- Demonstrate basics of vector calculus
- Apply the concept of probability distribution and sampling theory to engineering problems
- Apply principles of vector calculus to the analysis of engineering problems
- Identify, formulate and solve engineering problems
- Illustrate basic theory of correlations and regression

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to write at least 6 class tutorials on entire syllabus.

Recommended Books:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 402	Surveying–II	4.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	03	-	03	1.5	-	4.5

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	50	-	25	175

Rationale

This is an advanced course which intended to teach students modern surveying instruments with their principles and uses in surveying along with curves and setting out of different civil engineering works. Students are exposed to the concept of Total Station, G.P.S., G.I.S. and remote sensing techniques. To make the students acquainted with the field problems, a 4-day survey camp is arranged to execute the Road project, Block contouring project, Tachometric project and Total Station Traversing at ideal locations.

Objectives

- To understand operation of Total Station, EDM, Electronic Theodolite for desired accuracy in surveying.
- To learn how to establish survey control of determined accuracy using GPS, GIS and Remote sensing.
- To Study various types of curves by linear and angular methods.
- To prepare different layout from surveying data.
- To learn how to generate and manipulate field survey data and incorporate design data using specialized softwares.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Curves-Horizontal**		10
	1.1	Definitions of different terms, necessity of curves and types of curves	
	1.2	Simple circular curves, office and field work, linear and angular methods of setting out simple circular curves, problems on simple circular curve, compound curves, their needs and various types	
	1.3	Reverse and transition curves, their properties and advantages, design of transition curves, shift, spiral angle. Composite curves office and field work. Setting out of curves by angular method, composite curves problems.	
	1.4	Difficulties in setting out curves and solution for the same.	
II.	**Curves-Vertical**		3
	2.1	Tangent correction and chord gradient methods, , problems on the same	
	2.2	Sight distance on a vertical curve, problems on the same	
III.	**Setting out works**		4
	3.1	General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite	
	3.2	Setting out a foundation plans for building, sewer line, culvert, and use of laser for works; Setting out centre line for tunnel, transfer of levels for underground works.	
	3.3	Project/route survey for bridge, dam and canal;Checking verticality of high rise structures.	
IV.	**Special Survey Instruments**		6
	4.1	**Electronic Theodolite, Total Station:** Principles, Types, Applications, Topographical Survey and Stake-out, Transferring data to and from other software's for further processing, advantages and limitations	
	4.2	Introduction to Site square, Penta Graph, Auto-set Level, Transit level, Special Compasses, Brunton's Universal Pocket Transit, Mountain Compass Transit	

V.	**Modern Methods of Surveying**		12
	5.1	**Global Positioning System (GPS):** Basic principles, GPS segments, receivers, computations of coordinates, Applications in surveying	
	5.2	**Remote Sensing**: Definition, basic concepts, electromagnetic radiation and spectrum, energy source and its characteristics, image acquisition and image interpretation. Application of remote sensing.	
	5.3	**Geographical Information System (GIS)**: Geographical concepts and terminology, advantages, basic components of GIS, data types, GIS analysis, Applications of GIS.	
	5.4	**Field Astronomy**: Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.	
	5.5	**Aerial photogrammetry**: Introduction, Principle, Uses, Aerial camera, Aerial photographs, Definitions, Scale of vertical and tilted photograph, Ground Co-ordinates, Displacements and errors, Ground control, Procedure of aerial survey, Photomaps and mosaics, Stereoscopes, Parallax bar	
	5.6	**Hydrographic Survey:** Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders.	
VI.	**Cadastral Surveying**		4
	6.1	Interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property. Legal requirements relating to property boundary surveys in India	
	6.2	Role of revenue department in maintaining survey records, introduction to local survey terminologies like tehsildar, 7/12, utara, namuna8, etc. Introduction to Survey of India Department; Department of Registration and Stamps, Maharashtra	
		Total	**39**

Contribution to Outcomes

On completion of the course, the learners will be able to:

- Operate Total Station & GPS for desired accuracy in surveying and establish survey control of determined accuracy using Total Station, GPS, GIS and remote sensing.
- Set out various types of curves by linear and angular methods
- Compute setting out data from survey and design information.
- Generate and manipulate field survey data and incorporate design data using specialised software's.
- Appreciate the role of various governmental authorities in maintaining cadastral survey records.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus, the projects performed and practicals conducted. It will include a practical exam (10 marks) before proceeding for viva (15 marks)

List of Practicals:

1. To set out circular curve by linear methods.
2. To set out circular curve by angular methods.
3. Determination of horizontal and vertical distances, bearings and area using Total Station.
4. Determination of co-ordinates of a traverse, length of traverse lines using GPS
5. Post-processing of data obtained in Total Station & GPS practical using softwares like *TERRAMODEL*, *AutoCAD* etc. and print out the sheets
6. Analysis of survey projects conducted using computer by applying various softwares like MS excel, SurveyOS, surfit, QuikGrid, etc.
7. Setting out a simple foundation plan in the field.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work

It shall consist of the following:

1. **Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, Profile levelling, cross-sectioning, at least one simple and one reverse curve, plotting of L section and Cross Section. (Two full imperial sheet including plan, L–section and any three typical Cross-sections, sample data computation for curves, cutting and filling required
2. **Project II**: Block Contouring project using Auto level for minimum 100 × 80 m area and generating contours by MS Excel, etc. (minimum contour interval 0.2 meter)
3. **Project III:** Tachometric contouring project on hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours using software such as Autodesk land desktop, Auto civil, Foresight etc. (minimum contour interval 1 meter)
4. **Project IV:** Traversing using a total station (minimum 10 acres' area)
5. The account of practicals performed with aim, apparatus, observations, calculations, results and inferences
6. Field book submission on afore-mentioned practicals conducted on and off the field.
7. The assignments shall comprise of the minimum 5 problems covering the entire syllabus, theory questions on each chapter

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments.Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical performance	:	15 marks
Project (04)	:	20 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**50 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Surveying: *R. Agor*, Khanna Publishers, New Delhi
2. Surveying and Levelling: *N N. Basak*, Tata McGraw Hill, New Delhi.
3. Surveying and Levelling, Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
4. Surveying, Vol-I, II & III: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling, (2Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling, Vol.-I, II & III: *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling, Vol.-I& II:*S. K.Duggal*, Tata Mc-Graw Hill
8. Advanced Surveying, *R. Agor*, Khanna Publishers, New Delhi
9. Fundamentals of Surveying, *S.K. Roy*, Prentice Hall India, New Delhi
10. Remote Sensing and GIS, *B Bhatta*, Oxford University Press, New Delhi.
11. Remote sensing and Image interpretation, *T.M Lillesand, R.W Kiefer andJ.W Chipman*, 5th edition, John Wiley and Sons India
12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. &Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002
13. Remote Sensing and Geographical Information Systems. *Anji Reddy*, B.S.Publications, Hyderabad, 2001.

Web Materials:

1. http://nptel.ac.in/courses/105104100/1
2. http://www.surveyofindia.gov.in/
3. http://igrmaharashtra.gov.in/#

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 403	Structural Analysis–I	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

There are various types of the components of any civil engineering structures which are subjected to different types of loading or combination thereof. Most of the structures which are analyzed for finding its structural response which would form the basis for its structural design are indeterminate structure. Notwithstanding, the structural analysis of any civil engineering structural systems idealizing the same as the statically determinate one shall be the foundation of the analysis of the indeterminate structures. The knowledge gained in the subjects such as engineering mechanics and strength of materials in the preceding semesters where students have been exposed to the principles of engineering mechanics and subsequently, its application on the materials and solids to study its behavior under the action of loads and further to evaluate its strength properties, is extended in this subject for the analysis of various structural systems such as beams, frames, arches and suspension bridges.

Objectives

- To analyze the statically determinate simple portal frame (both- rigid jointed and having an internal hinges).
- To study the methods and evaluating rotation and displacement parameters in respect of beams and frames using various methods.
- To analyze the three hinged arches; and cables, suspension bridges and three hinged stiffening girder.
- To study the buckling behavior of the axially and transversely loaded beam-columns and its analyses.
- To understand the concept and behavior of the beam and trusses under rolling loads and subsequently, to obtain the absolute maximum bending moment.
- To understand the concept of unsymmetrical bending and shear center and its application in solving the problems of structural mechanics.

Detailed Syllabus

Module	Sub- Modules/ Contents	Periods
I.	**1.1 Axial force, shear force and bending moment**	6
	Concept of statically determinate structures; Axial force, shear force and bending moment diagrams for statically determinate frames with and without internal hinges.	
	1.2. General theorems and its application to simple structures	3
	General theorems and principles related to elastic structures, types of strain energy in elastic structures, complementary energy, principle of virtual work, Betti's and Maxwell's reciprocal theorems, Castigliano's first theorem, principle of superposition. Application of Energy Approach to evaluate deflection in simple structures such as simple beams, portal frame, bent and arch type structures, etc.	
II.	**2. Deflection of Statically Determinate Structures Using Geometrical Methods**	7
	Deflection of cantilever, simply supported and overhanging beams for different types of loadings Using-Integration Approach including Double Integration method and Macaulay's Method, Geometrical Methods including Moment area method and Conjugate beam method.	
III.	**3. Deflection of Statically Determinate Structures Using Methods Based on Energy Principle**	9
	3.1 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out slope and deflection in beams. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such structures.	
	3.2 Application of Unit Load Method (Virtual Work Method) for finding out deflection of rigid jointed frames. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such frames.	
	3.3 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out deflection in pin jointed frames (trusses). Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection intrusses.	
IV.	**4.1 Rolling Load and Influence Lines for Statically Determinate Structures**	8
	Influence lines for cantilever, simply supported, overhanging beams and pin jointed truss including warren truss, criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under moving loads (UDL and Series of point loads) for simply supported girder.	

	4.2 Three Hinged Elastic Arches	5
	Determination of normal thrust, radial shear and bending moment for parabolic and circular (semi and segmental) three hinged arches, Influence lines for normal thrust, radial shear and bending moment for three hinged parabolic arch.	
V.	**5. Cables, Suspension bridges and Three Hinged Stiffening Girder**	4
	Simple suspension cable, different geometries of cables, minimum and maximum tension in the cable supported at same/different levels, anchor cable, suspension cable with three hinged stiffening girder.	
VI.	**6.1 Columns and Struts**	4
	Columns and struts subjected to eccentric loads, Secant formula, Perry's formula, struts with initial curvature.	
	6.2 Unsymmetrical bending	3
	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	6.3 Shear Centre	3
	Shear centre for thin walled sections such as channel, tee, angle section and I-section.	
	Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Understand the behavior of various statically determinate structures including compound structures having an internal hinge for various loadings.
- Analyze these structures to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc.
- Evaluate the displacements / deflections in beams and frames under the action of loads. They will be able to obtain the response of the beams under the action of moving loads.
- Analyze the structures such as arches and suspension bridges and study the behavior of eccentrically loaded columns.
- Analyze the section with respect to unsymmetrical bending and shear center.
- Demonstrate the ability to extend the knowledge gained in this subject in the subjects *Structural Analysis-II* and elective subjects such as *Advanced Structural Analysis* and *Advanced Structural Mechanics* in the higher years of their UG programme where they will be dealing with the indeterminate structures. The knowledge gained in this subject shall also be useful for application in the structural design in later years.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments	:	20 Marks
Attendance	:	05 Marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: *S. B. Junnarkar and H.J. Shah*, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, *Vazirani and Ratwani*
4. Strength of Materials*: S. Ramamrutham,* Dhanpatrai and Publishers, Delhi
5. Theory of Structures: *S. Ramamrutham,* Dhanpatrai and Sons, Delhi
6. Structural Analysis I: *Hemant Patil, Yogesh Patil, Jignesh Patel*, Synergy Knowledgeware, Mumbai.
7. Strength of Materials*: Rajput*, S. Chand Publications, Delhi
8. Structural Analysis: *Bhavikatti*, Vikas publisher house Pvt, ltd.
9. Structural Analysis: *DevdasMenon*, Narosa Publishing House.
10. Basic Structural Analysis: K.*U. Muthu, Azmi Ibrahim, M. Vijyanand, MagantiJanadharnand. I.K.* International Publishing House Pvt. Ltd.
11. Comprehensive Structural Analysis: Vol-I and II by *Vaidyanathan R. and Perumal R.*Laxmi Publications.
12. Elementary Structural Analysis: *Jindal*
13. Structural Analysis: *L.S. Negi and R.S. Jangid,* Tata Mc-Graw Hill India
14. Fundamentals of Structural Analysis: *Sujit Kumar Roy and SubrotaChakrabarty*, S. Chand Publications.
15. Structural Analysis: *T.S. Thandavamoorthy*, Oxford University Press.
16. Structural Analysis: *Manmohan Das, Bharghab Mohan*Pentice Hall International.

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norries and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 404	Building Design and Drawing	3.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
02	03	-	02	1.5	-	3.5

Evaluation Scheme

Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	25	-	25	150

Rationale

Drawing is the language civil engineers communicate in. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

- To remember and recall the intricate details of building design and drawing.
- To gain an understanding of the basic concepts of building design and drawing.
- To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- To identify, analyse, research literate and solve complex building design and drawing problems.
- To design new solutions for complex building design and drawing problems.
- To effectively communicate ideas related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus			
Module	**Sub- Modules/ Contents**		**Periods**
I.	**1. Principles and Codes of Practices for Planning and Designing of Buildings**		**9**
	1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings	
	1.2	Principles of planning for residential buildings	
	1.3	Classification of buildings	
	1.4	Study of building Bye-laws and documents / permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
	1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
	1.6	Calculation of setback distances, carpet area, built-up area and floor space index (FSI)	
	1.7	Principles of planning for public buildings: i) Building for education: schools, colleges, institutions, libraries etc. ii) Buildings for health: hospitals, primary health centres etc. iii) Office buildings: banks, post offices, commercial complexes etc. iv) Building for public residence: hostels, boarding houses etc.	
II.	**2. Components and Services of a Building**		**5**
	2.1	Staircase (dog legged & open newel in details),	
	2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
	2.3	Openings: doors and windows	
	2.4	Types of pitched roof and their suitability (plan and section)	
	2.5	Building services: Water supply, sanitary and electrical layouts	
III.	**3. Perspective Drawing**		**4**
	3.1	One-point perspective	
	3.2	Two-point perspective	
IV.	**4. Town Planning, Architectural Planning & Built Environment**		**4**
	4.1	Objectives and principles (road systems, zoning, green belt etc.)	
	4.2	Master plan and slum rehabilitation	
	4.3	Architectural Planning: introduction and principles	

	4.4	Built Environment: introduction and principles	
V.	**5. Green Buildings**		**2**
	5.1	Introduction and overview	
	5.2	Certification methods (LEED and TERI)	
VI.	**6. Computer Aided Drawing (CAD)**		**2**
	6.1	Advantages of CAD	
	6.2	Overview of any one of the CAD software's prevailing in the market (AutoCAD, Revit, 3D Max etc.)	
		Total	**26**

Contribution to Outcomes

- Students will be able to list down the types of structures and its various components (for eg. doors, windows, staircase, foundations etc.)
- Students will be able to explain various concepts pertaining to building design and drawing (for eg, principles of planning, architectural planning, green buildings etc.)
- Students will be able to apply principles of planning, architectural planning and building bye laws while designing and preparing building drawings.
- Students will be able to calculate and analyze various technical details of a building (for eg. carpet area, FSI etc.) from its drawings.
- Students will be able to design various components of buildings (for eg. staircases etc.) as well as buildings as a whole, given the requirements of the building owner and local D.C. laws.
- Students will be able to prepare drawings (for eg. plans, elevation, perspective views etc.) of the designed components of buildings as well as buildings as a whole.

Theory Examination:

1. Question paper will consist of total 6 questions; each carrying 20 marks.
2. Question no. 1 will be compulsory and based on drawing work of any one building, maybe residential or public building
3. Any 3 out of the remaining 5 questions need to be attempted.
4. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Practical Examination (Oral and Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment') to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work

Reports:

1. Summary of Development Control (D.C.) rules of student's own or nearest city
2. Summary of documents required from commencement to completion of the building by the concerned local body i.e. Municipal Corporation or nearest Municipality.
3. One-day site visit could be arranged for students to visit any one public building near the college like commercial complex, library, Bank etc. They need to study in detail of that building take the measurements of that building should submit as a site report with detailed drawing according to some suitable scale. This will become a part of Term Work.

Drawings:

1. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a residential building (bungalow or apartment) to be constructed as a (G+1) R.C.C. framed structure
2. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a public building (school or hostel or hospital or bank) be constructed as a (G+1) R.C.C. framed structure
3. Roof plan, foundation plan (with section of a typical foundation), plan and section of staircase, one typical door and one typical window of either one of the two above drawings
4. One point and two-point perspective
5. CAD sheet of either one of the first two drawings

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Drawing Sheets : 10 Marks
Report of the Drawing : 05 Marks
Report on the Site Visit : 05 Marks
Attendance : 05 Marks
Total : 25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S. Y. Patki* (Tata McGraw-Hill Education)
2. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)
3. Planning and Designing Buildings by *Y.S.Sane* (Modern Publication House, Pune)
4. Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C.V.Vijayan* (SPADES Publication, Calicut)
5. Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in/documents/10180/7761832/5.pdf/e09991a2-b29e-4e04-a33e-a40aca6e2689?version=1.1)
4. Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5. Development Plan and Control Regulation for 27 villages of Kalyan and Ambernath tehsils of Thane district, Maharashtra (https://mmrda.maharashtra.gov.in)

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 405	Building Materials and Construction Technology	5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This subject provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing. This subject is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building construction system so that student can effectively plan and execute building construction work.

Objectives

- To study the manufacturing process, properties, and use of different types of building materials like cement, lime, mortar, concrete, stone, brick, timber, including materials such as paints and varnishes used for treatment of the surfaces so as to achieve good knowledge about the building materials.
- To enable the students to identify various components of building masonry, roof and floor, staircase etc., their functions and methods of construction so as to achieve good knowledge about building construction.
- To study the properties such as workability, durability and porosity of fresh and hardened concrete.
- To understand the concept and optimization of mix design for different environmental conditions.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.		**Introduction** Classification of materials, building materials symbols and requirements of building materials and products: functional, aesthetical and economical	4
II.		**Manufacturing Process and Properties of Basic Construction Materials.**	11
	2.1	Rocks (Stone) quarrying, milling and surface finishing, preservative treatments. **Aggregate**-Properties of coarse and fine aggregates and their influence on properties of concrete, properties of crushed aggregates.	
	2.2	**Structural clay products** -bricks, roofing tiles, ceramic tiles, raw materials and manufacturing process.	
	2.3	Concrete blocks, flooring tiles, paver blocks -raw materials and manufacturing process.	
	2.4	**Binder material**: lime, cement: Manufacturing process and physical properties, plaster of Paris -properties and uses.	
	2.5 2.6	**Mortar** -ingredients, preparation and uses. Damp -proofing and water proofing materials	
III.	3.1	**Concrete**	09
		Grades of concrete, Manufacturing process, Properties of fresh and hardened concrete. Durability -Factors affecting durability, Relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test.	
	3.2	**Admixtures**: Plasticizers, Super-plasticizers, Retarders, Accelerators, Mineral admixtures and other admixtures, test on admixtures, chemistry and compatibility with concrete.	
IV.	4.1	**Glass**: Types and uses. Introduction to glass fibre reinforced plastic.	04
	4.2	**Timber**: Varieties, defects in timber, preservative treatments and wood composites.	
V.	5.1	**Concrete mix design** Types of mix, Mix design for compressive strength by I.S. method, Mix design for flexural strength, Method of determining compressive strength of accelerated - cured concrete test specimens as per IS:9013-2004 (revised code)	10

	5.2	**Ready mix concrete**: Advantages of RMC, components of RMC plant, distribution and transport, handling and placing, mix design of RMC, Mass Concerting, Vaccum Concerting and Concreting Equipments	
VI.	6.1	**Masonry Construction and Masonry Finishes:** Classification and bonding of stone, brick and concrete blocks Masonry finishes -pointing, plastering and painting	14
	6.2	**Formwork** Materials used, design considerations, shuttering, centering and staging, scaffolding. Types of form work: Slip form work, Cantilever and other modern form work	
	6.3	**Floor and roof** Different types and its suitability. Type of roofs, wooden and steel trusses and roof covering Different types of cladding.	
		Total	**52**

Contribution to Outcomes

On completion of the course, the students will be able to:

- Identify and list the various building materials, their properties and symbols.
- Identify the properties of ingredients of concrete, interpret and design concrete mix for various grades.
- Explain and interpret manufacturing process of basic construction materials and understand various masonry construction and finishes.
- Perform tests on various materials.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practicals conducted by the students and a detail report of the industrial/ site visit.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

List of Practicals*(Any Eight to be performed)*:

1. Physical properties of cement: Fineness, consistency, setting time, Soundness, Compressive strength.
2. Water absorption and compressive strength test of bricks.
3. Water absorption and transverse load test on tiles.
4. Compression test on timber (Parallel/ perpendicular to the grains).
5. Effect of w/c ratio on workability, (slump cone, compaction factor, V-B test, flow table) and strength of concrete
6. Effect of w/c ratio on strength of concrete,
7. Study of admixtures and their effect on workability and strength of concrete
8. Secant modulus of elasticity of concrete and indirect tensile test on concrete
9. Nondestructive testing of concrete- some applications (hammer, ultrasonic)
10. Mix design in laboratory.

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall study various aspects of the plant along with various operations. A visit may also be arranged to the site involving repairs and rehabilitation of concrete structures. The visit to any site where construction is going on may be arranged and the students may be made aware of the various construction activities. They shall prepare a report of the visit which shall include all above points. The same shall be evaluated by the concerned teacher.

Term Work:

The term work shall consist of:

- Report of minimum **08** experiments.
- Assignments, including at least **20** sketches on A2 size drawing sheets covering entire syllabus.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.

- Although minimum numbers of experiments and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments.Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 Marks
Assignments	:	05 Marks
Sketches	:	05 Marks
Attendance	:	05 Marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidêlines shall be resorted to. 75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Building Construction: *S. P. Bindra and S. P. Arora*, Dhanpat Rai and Sons, Delhi.
2. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
3. Building Construction: *Rangwala*, Charotar Publications, Anand (Gujrat).
4. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
5. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
6. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman.
7. Concrete mix proportioning-guidelines (IS 10262:2009).
8. Concrete Technology: *A. R. Shanthakumar*, Oxford University Press.
9. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
10. Materials of Construction: *D. N. Ghose*, Tata McGraw Hill, Delhi.
11. Architectural Materials science: *D. Anapetor*, Mir Publishers.
12. Introduction to Engineering Materials: *B. K. Agrawal*, Tata McGraw Hill NewDelhi.
13. Engineering Materials: *P. Surendra Singh*, Vani Education Books New Delhi.
14. Building Materials (Products, Properties and Systems): *M.L. Gambhir and NehaJamwal*, Mc-Graw Hill Publications.
15. Specifications for different materials, BIS Publications, New Delhi
16. Properties of concrete: Neville, Isaac Pitman, London.
17. Relevant I.S. codes: Bureau of Indian standard.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 406	Fluid Mechanics–II	4

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme

Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study dealt with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

- To understand the Pipe flow problems, losses incurred during transmission of power through pipe and nozzle.
- To study hardy cross method and water hammer phenomenon
- To study and analyze the pipe network which will help to design water supply schemes.
- To study laminar, turbulent flows and its significance.
- To study compressible flow and understand boundary layer theory.

Detailed Syllabus			
Module	**Sub-module /Content**		**Periods**
I	**1. Flow through pipes:**		10
	1.1	**Flow through pipes:** Loss of head through pipes, Darcy-Weisbach equation, minor and major losses. Hydraulic gradient line and energy gradient line, pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flow through branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer:** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures.	
II	**2. Flow through nozzles:**		04
	Power transmitted through nozzle, condition for maximum power transmitted, diameter of nozzle for maximum transmission of power.		
III	**3. Compressible flow:**		05
	Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties.		
IV	**4. Boundary layer theory:**		07
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerges body, drag and lift, terminal velocity of body		
V	**5. Laminar Flow:**		05
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving. Kinetic energy correction factor, and momentum correction factor. Dash pot mechanism.		
VI	**6. Turbulent Flow:**		08
	Causes of turbulence, shear stress in turbulent flow, Prandtl's mixing length Theory, Hydro dynamically smooth and rough pipes, velocity distribution in smooth and rough pipes, Karman-Prandtl velocity distribution equation, Resistance to flow in smooth and rough pipes, resistance equation and Moody's diagram.		
		Total	**39**

Contribution to Outcomes

- On completion of this course the student will be able to:
- Interpret different pipe fittings and evaluate the fluid velocity considering major and minor losses.
- Solve pipe network problems by Hardy cross method.
- Distinguish the types of compressible flow and understand concept of boundary layer theory.
- Evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation for laminar flow in a pipe.
- Establish Prandtl's mixing theory and solve turbulent flow problems.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based on the entire syllabus and the report of the experiments conducted by the students including assignments.

List of Practicals (Any six experiments to be performed):

1. Reynold's Experiment
2. Determination of viscosity of fluid
3. Friction loss through pipes
4. Minor losses through pipes
5. Laminar flow through pipes
6. Velocity distribution in circular pipes
7. Turbulent flow through pipe
8. Water Hammer phenomenon

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report on Experiments	:	10 marks
Assignments	:	10 Marks
Attendance	:	05 Marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%–80%: 03 Marks; 81%–90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr P.M. Modi and Dr. S.M. Seth*, Standard book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company.
3. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar, F.K. Kataria.*
5. Fluid Mechanics and Hydraulics: *Dr. S. K. Ukarande*, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN 97893 8116 2538.
6. Fluid Mechanics: *R.K. Bansal* Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: *C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli*. Oxford Higher Education.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: *Streeter White Bed ford*, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: *R.L. Daugherty, J.B.Franzini, E.J., Finnemore*, Tata McGraw Hill New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India Pvt. Ltd., Delhi.

R16 TE

As per letter No. AA/ICD/20
780 dt. 12/12

UNIVERSITY OF MUMBAI

No. UG/44 of 2018-19

Again Revised syllabus
as per letter No: AAU/ICD/
2018-19/890 dt. 15.2.19.

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/248 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.55 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. in Civil Engineering (Sem - V & VI) has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
25th June, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.55/05/05/2018

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No. UG/44 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

Dean, Faculty of Science and Technology

Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development. Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, semester-based credit and grading system is also introduced to ensure quality of engineering education. Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scales to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017- 18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Dean(I/c) Faculty of Science and Technology,

Member - Academic Council,

University of Mumbai, Mumbai

Chairman

Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education in the process of curriculum development. As the Chairman, Board of Studies in Civil Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The Program Educational Objectives finalized for the undergraduate program in Civil Engineering are listed below; 1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals 2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems 3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process 4. To prepare the Learner for a successful career in Indian and Multinational Organisations In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome-based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. K. Ukarande

Chairman, Board of Studies in Civil Engineering,

University of Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		20	12	1	20	6	1	27

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	120	480	--	175	125	900

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai

Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (In Hrs.)				
		Test 1	Test 2	Avg						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	--	**19**	**7**	--	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	--	**150**	**925**

For the course 'Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course 'Business and Communication Ethics (CE-C 507)' will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying	CE-DLO6061: Advanced Construction Equipment
CE-DLO5062: Advanced Concrete Technology	CE-DLO6062: Traffic Engineering and Management
CE-DLO5063: Building Services and Repairs	CE-DLO6063: Ground Improvement Techniques
CE-DLO5064: Advanced Structural Mechanics	CE-DLO6064: Advanced Structural Analysis

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	2	--	4	1	--	5
CE-C703	Water Resource Engineering -II	3	2	--	3	1	-	4
CE-DLO704X	Department Level Optional Course-III	3	2	--	3	1	--	4
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**14**	**--**	**17**	**7**	**--**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 706), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai

Scheme of Instructions and Examination

Fourth Year Engineering (Civil Engineering)

(With effect from 2019-2020)

(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	--	2	4	--	1	5
CE-C802	Construction Management	4	--	2	4	--	1	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	1	3	--	1	4
CE-C804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**14**	**5**	**15**	**7**	**3**	**25**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	25	--	--	100
CE-P 804	Project – Part II	--	--	--			50	--	50#	100
Total		**80**	**80**	**80**	**320**		**150**		**125**	**650**

The oral examination for the Project- Part II (CE-P 806) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.

(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.

(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design CE-DLO7047: Applied Hydrology and Flood Control	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Design of Hydraulic Structures

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester-V

Semester V

Subject Code	Subject Name	Credits
CEC501	**Structural Analysis-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	4	1	-	5

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

There are various types of components in civil engineering structures, which are subjected to different types of loading or combinations thereof. The knowledge gained in the courses such as Engineering Mechanics, Strength of Materials and Structural Analysis -I is extended in this course. The scope of the course is to evaluate the response in the form of shear forces, bending moments, axial forces, and displacement parameters in various statically indeterminate structures such as beams, rigid and pin jointed frames. The course involves the concept of the displacement and flexibility approach for analysing the indeterminate structures. The course also involves the analysis of the indeterminate structures using the concept of plastic analysis and approximate analysis.

Objectives

- To revise the various concepts involved in the analyses of the structures studied in the course Structural Analysis-I.
- To analyze the statically determinate structures with reference to the variation in the temperature.
- To understand the concept of static and kinematic indeterminacy (degrees of freedom) of the structures such as beams & rigid pin jointed frames.
- To understand the concepts/ broad methods, sub-methods involved in the analysis of indeterminate structures.
- To apply various methods for analyzing the indeterminate structures to evaluate the response of such structures in the form of bending moment, shear force, axial force etc.
- To study the analyses of frame by approximate method.

Detailed Syllabus

Module	Sub Modules/Contents		Periods
1.	**General**		**04**
	Types of structures occurring in practice, their classification. Stable and unstable structures, static and kinematic determinacy and indeterminacy of structure. Symmetric structures, symmetrical & anti-symmetrical loads, distinction between linear and non-linear behaviors of material and geometric non-linearity. Two hinged arches: Introduction, classification and structural behavior (no numerical).		
2.	**Deflection of statically determinate structures**		**04**
	Introduction to the concept of complimentary energy, absolute & relative deflection caused by loads, temperature changes settlement of supports, application to beams, pin jointed frames, rigid jointed frames.		
3.	**Analysis of indeterminate structures by Force Method**		**14**
	3.1	Application of the Clapeyron's Theorem of Three Moments. Castigliano's theorem of least work Fixed Beams	
	3.2	Flexibility coefficients and their use in formulation of compatibility equations. Application to propped cantilevers, fixed beams, continuous beam and rigid jointed frames.	
	3.3	Application of flexibility method to simple pin jointed frames including effect of lack of fit for members.	
4.	**Analysis of indeterminate structures by Displacement Methods**		**18**
	4.1	Direct stiffness method: Stiffness coefficients for prismatic members, their use for formulation of equilibrium equations. Application to indeterminate beams & simple rigid jointed frames with inclined member but having only one translation degree of freedom.	
	4.2	Slope deflection method: Development of slope deflection equation, their use for formulation of equilibrium equations. Application to indeterminate beams & simple	

		rigid jointed frames with inclined member but having only one translation degree of freedom including the effect of settlement of supports.	
	4.3	Moment distribution method: Stiffness factor, distribution factor, Application to indeterminate beams & simple rigid jointed frames, having only one translation degree of freedom including the effect of settlement of supports.	
	4.4	Kani's Method: Fundamental equation of Kani's Method, application to simple beams and frames with single storey having two bays	
5.	**Plastic analysis of Steel structures**		**06**
	5.1	Introduction to plastic analysis, Concept of plastic hinge, plastic moment carrying capacity, shape factor.	
	5.2	Determination of collapse load for single and multiple span beams.	
6.	**Approximate Method for Analysis of Building Frames**		**06**
	6.1	Approximate method for gravity loads: Substitute frame method and equivalent frames.	
	6.2	Approximate method for lateral loads: Portal and cantilever method.	
		Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Understand the behavior of various statically indeterminate structures subjected to static loads and variation in temperature.
- Analyze the structures using displacement parameters to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc. for beams, 2D portal frames with various loads and boundary conditions, which becomes the basis for structural design.
- Contrast between the concept of force and displacement methods of analysis of indeterminate structures. Also, the elastic curve in beams and frames under the action of loads.
- Understand the concept of plastic hinge, plastic moment carrying capacity, shape factor and collapse load for single and multiple span beams.
- Find out the approximate dimensions of beams and columns using the approximate method for giving the input in design software. The knowledge gained in this subject shall also be useful for

application in the structural design in later years and also useful in the civil engineering field for the analysis purpose.

- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG Programme subjects such as Advanced Structural Analysis and Advanced Structural Mechanics in which they will be dealing with the indeterminate structures.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the tutorials and assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.
At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and Analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work:

- Assignments: 20 marks
- Attendance: 5 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Basic Structural Analysis: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Structural analysis: A Matrix Approach, Pandit and Gupta, Tata McGraw Hill publications.
3. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
4. Analysis of Structures: Vol. I and II, Vazirani and Ratwani
5. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, I K International publishing house, Pvt. ltd.
6. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
7. Comprehensive structural analysis (Vol. I and II), Vaidyanathan R., Laxmi publications
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: Devdas Menon, Narosa Publishing House.
10. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
11. Fundamentals of Structural Analysis: Sujit Kumar Roy and Subrota Chakrabarty, S. Chand Publications.
12. Structural analysis: Mohandas and Bhargab Mohan, Prentice hall international
13. Structural analysis: T. S. Thandavmoorthy, Oxford University Press

Reference Books:

1. Structural Analysis: Hibbler, Pentice Hall International.
2. Structural Analysis: Chajes, ElBS London.
3. Theory of Structures: Timoshenko and Young, Tata McGraw Hill New Delhi.
4. Element of Structural Analysis: Norries and Wilbur, McGraw Hill.
5. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
6. Structural theorem and their application: B.G. Neal, Pergaman Press.
7. Structural Analysis: Kassimali, TWS Publications
8. Fundamentals of Structural analysis: K.M. Leet, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: Heish, Prentice Hall

Semester V

Subject Code	Subject Name	Credits
CEC502	Geotechnical Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	**25**	**150**

Rationale

All civil engineering structures rest on ground i.e. supported by soil and rock. Rock is rarely occurring and hence mostly the supporting medium is soil. Hence the stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basics of physical properties which are useful for determining the strength, compressibility, drainage etc. The soil mechanics is the basic tool for geotechnical engineering which is the specialized section of civil engineering. Soil is also used as construction material to make various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I

Objectives

- To study the types of soil and relationships involving the weight, volume and other parameters of soil.
- To study the index properties of soil which is measure of the engineering properties and classify the soil based on different classification systems.
- To study the properties of soil related to flow of water.
- To study the concept of total stress, neutral stress & effective stress in soil.
- To understand the load deformation concept through compaction process.
- To understand the techniques of soil exploration, assessing the subsoil conditions & engineering properties of various strata along with presentation of report.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction to Geotechnical Engineering, Basic Definitions & Relationships**		**07**
	1.1	Definitions: Rocks, Soil, origin & mode of formation and type of soil obtained, soil mechanics, rock mechanics, soil engineering, geotechnical engineering	
	1.2	Scope of soil engineering: Importance of field exploration and characterization	
	1.3	Cohesionless & cohesive soils	
	1.4	Soil as three-phase & two-phase system in terms of weight, volume, void ratio, porosity	
	1.5	Weight-volume relationship: water content, void ratio, porosity, degree of saturation, air voids, air content, different unit weights, specific gravity of solids, and mass, absolute specific gravity.	
	1.6	Relationship between: different unit weights with void ratio, degree of saturation, specific gravity; different unit weights with porosity, void ratio, water content; different unit weights with water content, unit weights air voids.	
	1.7	Mention different methods to find water content, specific gravity, unit weight of soil (Detailed description to be covered during practical)	
2.	**Plasticity Characteristics of soils**		**06**
	2.1	Plasticity of soil: Definition of plasticity of soil, reason of plasticity, consistency of soil, explanation about idea set by Atterberg in defining the three states of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.2	Definitions of shrinkage parameters; plasticity index, shrinkage index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soils. Use of consistency limits	
	2.3	Explanation about clay minerals e.g. montmorillonite, illite, and kaolinite; their formation and role in producing the plastic behavior in soil	

3.	**Classification of soils**		06
	3.1	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498, boundary classification	
	3.2	Mechanical sieve analysis: wet & dry sieve analysis, combined sieve & sedimentation analysis, Stokes's law, hydrometer method of analysis, relation between percent finer and hydrometer reading. Limitation of sedimentation analysis, particle size distribution curve/gradation curve and its use	
	3.3	Relative density	
4.	**Permeability of soils & seepage analysis**		10
	4.1	Introduction about ground water flow: water table, types of aquifers, types of soil water, explanation of surface tension with capillary rise in small diameter tubes, capillary rise in soils	
	4.2	Definition of hydraulic head, hydraulic gradient, Darcy's law, laminar flow through soil, validity of Darcy's law.	
	4.3	Definition of permeability of soil, numerical values for different types of soils, determination of coefficient of permeability of soil in lab using constant head and variable head methods. Determination of in-situ permeability with pumping out and pumping in test. Permeability from indirect methods e.g. empirical equation & from consolidation data	
	4.4	Permeability of stratified soil deposits	
	4.5	Definition of seepage and its importance for the study of analysis & design of hydraulic structures. Derivation of Laplace equation for two-dimensional flow, its analytical solution representation by stream & potential function; Graphical representation by flow net, definition of flow line, equipotential lines, flow channel, field, characteristics of flow net, use of flow net	
	4.6	Solution of Laplace equation by other methods e. g. numerical methods	
5.	**Effective stress principle**		03
	5.1	Definition of geostatic stresses, vertical stress/total stress, neutral stress/pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage	

		pressure on effective stress; quick sand condition.	
6.	**Compaction of soils & soil exploration**		**07**
	6.1	Theory of compaction, determination of Optimum Moisture Content (OMC) & Maximum Dry Density (MDD) in laboratory by conducting the light and heavy compaction test.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, relative compaction	
	6.3	Necessity of soil exploration, methods of investigation, methods of boring, types of soil samples, soil samples sampling, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometers tests: SPT, SCPT, and DCPT.	
	6.5	Representation of data with borehole logs.	
		Total	**39**

Contribution to Outcomes

With the completion of this course, the students will be able to:

- Understand the soil types, index and engineering properties and relationship between various unit weights & other parameters.
- Classify the soil with a view towards assessing the suitability of a given soil for use; either to use if to support a structure (e.g. embankment) or to construct a structure therein (e.g. foundation)
- Understand the use of geosynthetics in soil to improve soil properties.
- Evaluate the compaction characteristics in laboratory & field and hence interpret the results with compaction specifications.
- Interpret soil boring data for foundation design.
- Conduct laboratory experiments to collect, analyze, interpret and present the data

Theory Examination:

1. Question paper will comprise of **six** questions: each having 20 marks.
2. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining 5** questions will be based on all the modules of entire syllabus. For this module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.

4. There can be an internal choice in various sub-questions/questions in order to accommodate the questions on all the topics/sub-topics.
5. The students will have to attempt **any three** questions out of **remaining 5** questions.
6. **Total four** questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work consisting of the report of experiments performed in the laboratory and assignment.

List of Experiments/Practical: (At least 8 to be performed)

1. Determination of natural moisture content using oven drying method

Following other methods to find moisture content shall be explained briefly:

a) Pycnometer method
b) Sand bath method
c) Alcohol method
d) Torsional balance method
e) Radio activity method
f) Moisture meter

2. Specific gravity of soil grains by density bottle method or pycnometer method
3. Field density using core cutter method
4. Field density using sand replacement method
5. Field identification of fine grained soils
6. Grain size distribution by sieve analysis
7. Grain size distribution by hydrometer analysis
8. Determination of liquid & plastic limit
9. Determination of shrinkage limit
10. Liquid limit by cone penetrometer method
11. Permeability using constant head method
12. Permeability using falling head method
13. Compaction test, IS light compaction test/ Standard Proctor test
14. Compaction test, IS heavy compaction test/ Modified Proctor test
15. Relative density test

Term Work:

a) The term work shall be comprised of the neatly written report based on the experiments performed in the laboratory as well as assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each modules/ sub-module content thereof further.

b) One assignment should be given on Geosynthetics. The teacher is expected to deliver extra lectures on geosynthetics for the entire class, thereby conveying the importance of the same to the students. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Definition of geosynthetics, types of geosynthetics: geotextiles, geogrids, geo cells, geomembranes, geo composites; types of geotextiles: woven and non-woven etc.; physical properties: apparent opening size (AOS), specific gravity, mass per unit area, thickness; basic hydraulic properties: permittivity, transmissivity of geotextile
- Filter design criteria for graded soil & geotextile filters

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the term work, assignments, and experiment reports. The final certification acceptance of term work warrants the satisfactory and appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments : 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Soil Engineering in Theory and Practice; *Alam Singh*, CBS Publishers Distributors, New Delhi
2. Soil Mechanics and Foundation Engineering: *V. N. S. Murthy*; Saitech Publications
3. Soil Mechanics and Foundation Engineering: *K. R. Arora*; Standard Publishers and Distributors, New Delhi

4. Soil Mechanics and Foundations: *Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain*; Laxmi Publications, New Delhi
5. Geotechnical Engineering: *C. Venkat Ramaiah*; New Age International
6. Fundamentals of Soil Engineering; *D. W. Taylor*, John Wiley & Sons.
7. An Introduction to Geotechnical Engineering: *R. D. Holtz*, Prentice Hall, New Jersey
8. Soil Mechanics: *R. F. Craig*, Champion & Hall
9. Soil Mechanics: *T. W. Lambe, R. V. Whitman*, John Wiley & Sons.
10. Designing with Geosynthetics: *R. M. Koerner*, Prentice Hall, New Jersey.
11. An Introduction to soil reinforcement geosynthetics: *G. L. Sivakumar Babu*, Universities Press.
12. Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC503	**Applied Hydraulics**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	**150**

Rationale

The knowledge of this course is essential to understand facts, concepts and design parameters of dynamics of fluid flow, application of momentum equation in lawn sprinklers and pipe bends, dimensional analysis and impact of jets. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines and design of open channels and flow through open channels.

Objectives

- To introduce the concept of dynamics of fluid flow and dimensional analysis
- To study hydraulic machines like centrifugal pumps, reciprocating pumps and turbines.
- To study the mathematical techniques used in research work for design conducting model tests.
- To impart the dynamic behavior of the fluid flow analyzed by the Newton's second law of motion.
- To understand the uniform and non-uniform flow through open channels.
- To study design of open channel and understand concept of surface profile with hydraulic jump.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
1.	**Dynamics of Fluid Flow**	04
	Momentum principle (applications: pipe bends), moment of momentum equation (applications: sprinkler).	

2.	**Dimensional Analysis:**		05
	Dimensional homogeneity, Buckingham's π theorem, Reyleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynold's model law, Froude's model law, scale effect in models.		
3.	**Impact of Jets:**		07
	Introduction, force exerted on stationary flat plate: held normal to jet, held inclined to jet, hinged plates, curved plate: Stationary and Moving, symmetrical and unsymmetrical (Jet striking at Centre and jet striking tangentially at one end).		
4.	**Hydraulic Turbines:**		11
	General layout of hydro-electric plant, heads, efficiencies of turbine, classification, working of Pelton Wheel Turbine, Reaction Turbine, Francis Turbine, Kaplan Turbine and draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.		
5.	**Centrifugal pumps:**		03
	Work done, heads, efficiencies, Minimum speed; series parallel operation, Multistage pumps, specific speed, model testing, priming, characteristic curves, cavitations. Brief introduction to reciprocating pump.		
6.	**Flow through open channels**		09
	6.1	Uniform Flow: Flow through open channel: Definition, types of channels, Types of flows in channels, Prismatic, non-prismatic channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-section (most economical section).	
	6.2	Non-Uniform Flow: Specific energy and specific energy curve, Specific force, Hydraulic jump and standing wave. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles.	
		Total	**39**

Contribution to Outcomes

On completion of this course the student will be able to:

- Apply the concepts of fluid dynamics to solve pipe bend and sprinkler problems.
- Analyze dimensional problems and explain model laws.
- Explain the working and functions of Francis, Kaplan and Pelton wheel turbines.
- Explain the basic concepts of open channel hydraulics and measure discharge through open channels.
- Identify the occurrence of hydraulic jump and its parameters
- Explain uniform flow, non-uniform flow and establish mathematical relationships.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions **out of remaining five** questions.
5. **Total four** questions need to be attempted.

Oral Examination:

The oral examinations shall be based on the entire syllabus, the report of the experiments conducted by the students including assignments.

List of Experiments (Any six):

1. Impact of jet on flat plate/inclined plate/curved plate.
2. Performance of Pelton wheel- full gate opening.
3. Performance of Centrifugal pumps.
4. Performance of Kaplan turbine.
5. Performance of Francis turbine.
6. Determination of Chezy's roughness factor.
7. Study of gradually varied flow.

8. Study of hydraulic jump and its characteristics.
9. Calibration of Venturi-flume/Standing wave flume.

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:
75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Hydraulics and Fluid mechanics: *Dr. P.N. Modi* and *Dr. S.M. Seth*, Standard Book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company, New Delhi.
3. Fluid Mechanics: *A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and Hydraulics: *S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
5. Fluid Mechanics and Fluid Pressure Engineering: *D.S. Kumar, F.K. Kataria* and sons 6. Fluid Mechanics: *R.K. Bansal*, Laxmi Publications (P) Ltd.
6. Flow in Open Channels: *K. Subramanya*; Tata Mc-Graw Hill Publishing House Pvt. Ltd.
7. Irrigation and Water Power Engineering: *B. C. Purnnia.*; Standard Publishers, New Delhi.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications: *R.L. Daugherty, J.B. Franzini, E.J. Finnemore,* Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: James F. Cruise, *Vijay P.Singh and Mohsen M. Sherif,* CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: *Edward J. Shaughnessy, Ira M. Katz, James P. Schaffer.* Oxford Higher Education.

Semester V

Subject Code	Subject Name	Credits
CEC504	**Environmental Engineering-I**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	**25**	**-**	**25**	**150**

Rationale

Environmental engineering is important for all human endeavours not simply about construction within the environment. This course lays emphasis on the practical application of knowledge, while at the same time recognizing the importance of theoretical knowledge in developing the intellectual capacity of the engineer. Knowledge of this course is useful for planning, designing, execution monitoring water supply sanitary schemes for the towns/cities. The scope of the course is to also solve the issues related to air and noise pollution.

Objectives

- To prepare students who can accomplish planning, design and construction of water systems and related infrastructural facilities.
- To provide the necessary knowledge on quality of water, concepts in the field of water supply and treatment.
- To impart necessary skill for the design and operation of water treatment plants.
- To introduce new developments in the field of water treatment and to inculcate the students with sound theoretical knowledge in engineering sciences as well as in research consultancy skills.
- To give a practical oriented knowledge so that they can give the practical solutions to environmental problems in the society and also to provide basic understanding of air pollution and monitoring.
- To impart positive responsive vocational attitudes, initiative creative thinking in their mission as an Engineers. Also provide the basic understanding of noise pollution.

Detailed Syllabus

Module		Sub Modules / Contents	Periods
1		**Water Supply and Distribution of Water**	03
		Water resources, Water supply systems, distribution systems of water, types of intake structure, water demand.	
2		**Quality of Water**	04
		Wholesomeness and palatability, physical, chemical, Biological standards, Treatment of water, drinking water standards, environmental chemistry, Eutrophication, Primary, Secondary and Tertiary treatment of water. Typical water treatment flow diagram.	
3	3.1	**Aeration and Sedimentation**	04
		Aeration, Types of Aeration systems, Theory and factors affecting efficiency of sedimentation, design of sedimentation tank and tube settlers.	
	3.2	**Coagulation and flocculation**	06
		Mechanisms, common coagulations, rapid mixing and flocculating devices, Jar test, coagulant aids – PAC.	
	3.3	**Filtration**	05
		Classification, slow and rapid sand filters, dual media filters, under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, head loss in filters and numerical on head loss, pressure filters: construction and operation.	
	3.4	**Water Softening**	02
		Lime soda and base exchange methods, Principle reactions, design considerations, sludge disposal.	
	3.5	**Disinfection**	03
		Chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, super chlorination, de-chlorination, chlorine residual, uses of iodine, ozone, ultra violet rays and chlorine dioxide as disinfectants, well water disinfection	

	3.6	**Advanced and Miscellaneous Treatments**	03
		Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese, taste, odour and colour, principles and methods, de-fluoridation.	
4	4.1	**Building Water supply**	02
		Introduction – Per Capita Supply, Determination of storage capacity, Service connection from main, water meter.	
	4.2	**Sanitary Fixtures**	
		Sanitary Fixtures and fittings: Introduction, classification of fixtures, soil fixtures, bathroom accessories, special accessories, fittings	
5		**Rainwater Harvesting**	02
		Need for rainwater harvesting, Annual potential, Collection of rain water for direct use or ground water recharge, Roof-top rain water harvesting	
6	6.1	**Air Pollution**	03
		Air-Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution-automobile pollution, Air quality standards, Control measures for Air pollution, construction and limitations	
	6.2	**Noise**	02
		Basic concept, measurement and various control methods. Thermal pollution.	

Contribution to Outcomes

After completion of the course the student will be able to:

- Understand the water supply system, its components and water demand by various consumers.
- Understand and analyze the quality of water and will be able to conduct the quality control test on samples.
- Understand the different processes in the water treatment facility.
- Design the different units of treatment for water treatment plants.
- Understand the components of building water supply system, storage and rain water harvesting.

- Understand the problems of air and noise pollution. Besides, they will be prepared to contribute practical solutions to environmental problems in our society.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and it will consist of short questions will have weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted.

List of Practical: (Any eight to be performed)

1. Determination of pH of water.
2. Determination of Alkalinity of water.
3. Determination of Hardness of water.
4. Determination of Turbidity of water.
5. Determination of Optimum dose of coagulant by using Jar Test Apparatus.
6. Determination of Dissolved Oxygen of Water.
7. Determination of Residual chlorine in water.
8. Determination of chlorides in water.
9. Most Probable Number.
10. High Volume Sampler.
11. Determination of Level Equivalent of Noise.

Site Visit:

The students should visit the Water Treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

Mini Project: (Any one)

A mini project shall comprise of

1. Design a basic plumbing system for water supply for residential/commercial building.

2. A case study for any existing structure.
3. Model making.
4. Software based design of water distribution system.

Term Work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory and Mini Project report. A detailed report on the visit to water treatment plant will also be submitted as a part of the term work.

Oral Examination:

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the site visit and the minimum passing marks to be obtained by the student.

The following weightage of marks shall be given for different components of the term work.

- Assignments & Experiments: 05 Marks
- Internal Oral examination based on Experiments and Assignments: 05Marks
- Mini Project: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:
75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi.
2. Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi
3. Plumbing Engineering Theory and Practice: S.M. Patil, Seema Publication, Mumbai.
4. Water Supply and Sewage: E.W. Steel, McGraw Hill, New York.
5. Water Supply and Sewage: T.J. McGhee, McGraw Hill, New York.

6. CPHEEO Manual on Water Supply and Treatment.
7. Water Supply Engineering: P.N. Modi, Rajsons Publication.
8. Water Supply Engineering: S. K. Garg, Khanna Publication.
9. Environmental Engineering (Vol. II)- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publication
10. Introduction to Environmental Engineering: Vesilind, PWS Publishing company.
11. Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.
12. Relevant Indian standard specifications.
13. Environmental Pollution: Gilbert Masters.
14. Basic Environmental Engineering: J.A. Nathanson, Prentice Hall of India.
15. Environmental Engineering: Sincero And Sincero.
16. Air pollution: *M. N Rao.,* Tata Mc Graw Hill, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC505	Transportation Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Transportation contributes to the economical, industrial, social and cultural development of any country. The adequacy of transportation system of a country indicates its economic and social development. Three basic modes of transportation include land, water and air. The land mode further gives rise to highways and railways. The highways owing to its flexibility in catering door-to- door service forms one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways for urban and rural areas. This course also deals with the planning, operation and control of the traffic.

Objectives

- To give insight of the development in the field of highway engineering, right from inception up to construction and maintenance and to familiarize the students with different surveys required to be carried out for the implementation of the highway project.
- To enable the students to understand the phase of engineering which deals with the planning and geometrics design of streets, highways, abutting land and with traffic operations thereon w.r.t. safe, convenient and economic transportation of people and goods.
- To enable the students to understand the properties of the different materials to be used in the construction of highways and other allied structures, characterize the materials and evaluate their suitability;
- To understand the principle of soil stabilization along with its significance and different types of stabilization techniques; and also, to study the concept of reinforced soil in the construction of highway and allied structures.

- To enable the students to understand the classification and behaviour of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements using various design methodologies
- To study the various methods of construction of different types of pavements including semi-rigid pavements and composite pavements, to study the different types of distresses in pavements, evaluation of existing pavements and methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Highway Planning and Development/ Highway Alignment and Surveys**		**03**
	1.1	Classification of roads based on the different criteria; brief history of road developments in India; present status of roads development programme in India, including different programmes being executed by various agencies.	
	1.2	Highway alignment, basic requirement of ideal alignment, factors governing highway alignment.	
	1.3	Different types of surveys for Highway location survey, map study, reconnaissance, topographic surveys, highway alignment in hilly area, drawing report preparation.	
2.	**Geometric Design of Highway**		**07**
	2.1	Terrain classification, vehicular characteristics, highway cross section elements, salient dimensions, clearances, width of carriage way, shoulders, medians, width of road way, right of way, camber along with its profile (IRC Standards).	
	2.2	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.3	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.4	Gradients: Different types of gradients (maximum, minimum, ruling, exceptional) grade compensation in curves, vertical curves: design factors, comfort sight distance, summit curve, valley curve.	

3.	**Traffic Engineering**		05
	3.1	Different Traffic Studies: Speed Studies (Spot Speed, Speed and Delay Studies), Traffic Volume, Parking Studies, Significance/ applications of these studies; different methods of conducting traffic studies, Methods of the presentation of data.	
	3.2	Introduction to relationship between Speed, density and volume; Capacity: Different types and factors affecting the capacity, concept of Passenger Car Units (PCU) and Level of Service (LoS).	
	3.3	Introduction to different types of Traffic Control Devices: Traffic signs, signals (no design), road marking.	
	3.4	Different types of intersections: At grade and grade separated; grade separated interchanges; rotary intersections.	
4.	**Highway Materials**		06
	4.1	Subgrade materials: desirable properties, modulus of elasticity, modulus of subgrade reaction, classification of subgrade soils, different strengths, various tests to be conducted to evaluate the suitability of the soil as the highway material.	
	4.2	Sub-base material: desirable properties, different tests to be conducted on aggregate, requirement of aggregate for different types of pavements.	
	4.3	Bituminous materials: types of bituminous material, test on bituminous material, desirable properties, grade of bitumen.	
	4.4	Soil Stabilization: Significance; principle of soil stabilization; different methods of soil stabilization, use of Geosynthetics in highways and allied structures.	
5	**Highway Pavement Design**		09
	5.1	Types of pavements: Flexible, Rigid, Semi-Rigid and composite; comparison between them vis-à-vis based on the structural behavior and other parameters; Factors affecting design of pavements including traffic factors (Design wheel load, equivalent single wheel load, equivalent wheel load factor/VDF)	
	5.2	Flexible pavement: Various approaches of designing the pavement and methods falling under each category (theoretical, semi-theoretical or	

		semi-empirical, empirical, mechanistic empirical and methods based on road performance); Overview of the method prescribed by IRC along with the modifications incorporated therein time to time (IRC: 37- 1970, 1984, 2001 and 2012); Design of the pavement using IRC: 37- 2001 and IRC: 37- 2012 with a more emphasis on latest IRC Code); Introduction to the design of low volume flexible pavement (IRC: SP 72- 2007/2015 and IRC: 77-2008).	
	5.3	Rigid Pavements: Introduction to the different types of rigid pavements (plain jointed, plain jointed reinforce, continuous reinforced, fiber reinforced, roller compacted concrete); Analysis of the stresses to be developed in the pavement (wheel load, warping and frictional); critical combination of the loading; Overview of the various approaches (Analytical, Empirical and Mechanistic empirical) of designing the pavements and methods falling under the respective category; overview of the methods prescribed by IRC along with modifications incorporated therein time to time (IRC: 58-1974, 58-1988; 58-2002 and 58-2015); Design of plain jointed rigid pavements (IRC: 58- 2002 and IRC: 58- IRC: 58- 2015 with more emphasis on IRC: 58-2015) including design of joints; Introduction to the design of low volume rigid pavement using (IRC: SP- 62-2004 and IRC: SP- 62-2014)	
6.	**Highway Construction/ Drainage/ Rehabilitation and maintenance**		**09**
	6.1.	Construction of different types of roads: Introduction to the water bound macadam (WBM), wet mix macadam (WMM), bituminous pavements, plain jointed cement concrete pavements and along with various joints (as per IRC/ MORTH specifications), jointed reinforced, continuously reinforced; fiber reinforced, roller compacted concrete pavements.	

	6.2	Pavement failure: Classification of distresses in pavements (functional and structural); different types of distresses in flexible and rigid pavements along with the causes and remedial measures; various types of maintenance pavements; evaluation of pavements: functional and non-destructive evaluation of pavement, various equipment used in evaluation of pavements along with their principles (Profilometer, bump integrator, Benkelman beam, lacroixdeflectograph, falling weight deflectometer) and utility in the evaluation.	
	6.3	Strengthening of existing pavement: Objective of strengthening, different types of overlay, design of flexible overlays on flexible pavement using effective thickness approach, and deflection approach resorting to Benkelman Beam method (IRC: 81-1981) and Mechanistic Empirical approach using deflection (IRC: 81-1997); Introduction to the design of other types of overlays.	
	6.4	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage- surface and subsurface drainage inkling for the roads in hilly areas.	

Contribution to the Outcomes

On successful completion of the course, the students shall be able:

- To get an insight of the development in all the fields of highway engineering and familiarized with different surveys required to be carried out for the implementation of the highway project; to understand the phase of engineering which deals with the planning and geometrics design of streets, highways and abutting land in the context of safe and convenient traffic operations thereon.

- To know the required properties of the different materials to be used in the construction of highways and other allied structures, to understand characterization of the materials and to evaluate their suitability; understand the principle of soil stabilization, utilization of geosynthetics in the construction of highway and allied structures

- To understand the classification of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements and can the flexible and rigid pavements be using IRC Specifications.

- To get an insight into the methods of construction of different types of pavements; along with the importance of highway drainage and various methods of providing the drainage; also, to understand the elements of bridge engineering.
- To illustrate different distresses in the pavements, evaluate the pavements in terms of its functional and structural adequacy and arrive upon the rehabilitation measures.
- To explain methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. There can be **an internal choice** either in the main question or sub-question to accommodate the contents of all the modules.
5. The students will have to attempt **any three** questions **out of remaining five** questions.
6. **Total four** questions need to be attempted.

Oral Examination:

The oral examinations shall be based on the entire syllabus the report of the experiments conducted by the students including assignments and the Traffic Survey Report.

List of Practical:

Although it is recommended that 12 experiments are desirable, at least nine should be performed.

1. Impact test on aggregates
2. Abrasion test on aggregates
3. Crushing test on aggregates
4. Shape test on aggregates
5. Soundness test
6. Polished stone value test

7. Stripping value or bitumen adhesion test (water sensitivity)
8. Penetration test on bitumen
9. Ductility test on bitumen
10. Softening point test on bitumen
11. Viscosity test on bitumen
12. Flash point and fire point test on bitumen
13. Marshall stability test on the bituminous mix
14. CBR test on subgrade soil material (Laboratory or Field)
15. Plate bearing test on subgrade soil

Term Work:

The term-work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. There shall be at least 10 assignments which will comprise of numerical problems and lay-out sketches, covering the entire syllabus divided properly module wise. In addition to this, the students shall conduct any one of the traffic surveys and will prepare a detail report thereof. This report shall also form a component part of the term work.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Traffic Study Report: 04 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%-80%: 03, Marks: 81%-90%: 04, Marks: 91% onwards: 05 Marks.

Recommended Books:

1. Highway Engineering: *Khanna, S.K., Justo, C. E. G. and Veeraraghavan A*; NemChand and Bros., Roorkee (Revised 10th Edition)
2. Principles and Practice of Highway Engineering: *Kadiyali, L. R.*; Khanna Publishers, Delhi
3. A Text Book of Highway and Traffic Engineering: *Saxena, Subhash Chandra*; CBS Publishers and Distributors (2014)

4. A Text Book of Highway Engineering: *Sriniwasakumar, R.*; University Press, Hyderabad (First Published in 2011; Reprinted in 2013)
5. Transportation Engineering (Vol.-I)- Highway Engineering: *Venkatramaiah, C.*; University Press, Hyderabad (2016).
6. Principles of Transportation and Highway Engineering, *Rao, G.V.;* Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
7. Principles, Practice and Design of Highway Engineering (Including Airport Engineering): *Sharma, S.K.;* S. Chand and Company Pvt. Ltd., New Delhi.
8. Principles of Transportation Engineering: *Chakraborty, Partha and Das, Animesh*; Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

Reference Books:

1. Transportation Engineering and Planning: *Papacostas, C.S. and Prevedouros, P.D.*; Prentice Hall India Learning Pvt. Ltd., New Delhi.
2. Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.;* Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Traffic Engineering and Transport Planning: *Kadiyali, L.R.*, Khanna Publishers, Delhi
4. Pavement Design: *Srinivasakumar, R*; University press, Hyderabad (First Published 2013; Reprinted in 2015).
5. Highway Material and Pavement Testing: *Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.;*Nem Chand and Bros., Roorkee, India.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Planning related aspects in the context of Highway Geometrics/ Traffic Planning/ Pavement Design and Highway Construction)

Note: Some of the recent specifications may not have been incorporated in few books. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes shall be referred to.

Semester V

Subject Code	Subject Name	Credits
CE-DLO5061	Department Level Optional Course – I: Advanced Surveying	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

This is an advanced course which is intended to teach students about applications of modern surveying instruments with their principle and uses in surveying for different civil engineering works. Student should get exposed to the concept of Total Station, G.P.S., G.I.S. and Remote Sensing techniques. To make the students acquainted with the field problems, various groups of students not less than 2 and more than 4 should be formed, and they will research on use of various Geospatial tools for tackling problems based on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.

Objectives

On completion of the course, the student will be able to:

- Use Total Station & GPS for desired requirements in surveying.
- Establish surveying control to determine required accuracy using Total Station, GPS, GIS and remote sensing.
- Stake out the designed data by using modern high precision surveying instruments.
- Generate and utilize field surveying data and incorporate design data using specialized software.
- Critically evaluate the use of advance positioning instrument for surveying and setting out.
- Apply GIS for solving civil engineering problems.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Modern Surveying Equipment**		3
	1.1	Introduction.	
	1.2	Electronic Distance Measuring Instrument (EDMI), Use of lasers in Surveying	
	1.3	Electronic Theodolite, Total Station and Scan Station	
2	**Global Positioning System**		8
	2.1	Basics of GPS, Positioning using satellites, GPS principles, GPS receivers, GPS principles	
	2.2	GPS errors and accuracy Error sources in GPS observations Satellite geometry and accuracy measures	
	2.3	GPS measurements techniques, GPS algorithms/Navigational solutions Other satellite navigation systems and GPS modernization	
	2.4	Civil engineering application of GPS	
3	**Photogrammetry**		6
	3.1	Introduction to geometry of vertical photographs Geometry of tilted photographs, photogrammetric terms; Applications; Type of photographs; perspective geometry of vertical and tilted photographs, heights and tilt distortions;	
	3.2	Flight planning; Stereoscopy, base lining, floating marks, parallax equation and stereo measurements for height determination, Developments in photogrammetry: analogue, analytical and digital methods, photogrammetric instruments.	
	3.3	Civil engineering application of photogrammetry	
4	**Remote Sensing**		10
	4.1	Introduction: Physical basis of remote sensing- Electro-magnetic radiation (EMR)- nature, nomenclature and radiation laws; Interaction in atmospheric nature, its effects in various wavelength regions, atmospheric windows;	

		interaction at ground surface- soils and rocks, vegetation, water, etc.; Physical basis of remote sensing (Radiometry)	
	4.2	Geometric basis of interaction, Platform and sensors, Terrestrial, aerial and space platforms; Orbital characteristics of space platforms, sun and geo-synchronous; Sensor systems radiometers, optomechanical and push broom sensor; Resolution- spectral, spatial, radiometric and temporal; Data products from various air and spaceborne sensors- aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS, etc. Image interpretation- Elements of interpretation; Manual and digital interpretation; Field verification	
	4.3	Remote sensing: Image Interpretation, Introduction to image processing techniques, Image enhancement, Information extraction	
	4.4	Civil engineering application of Remote Sensing	
5	**Geographical Information System**		8
	5.1	Introduction to GIS, its hardware and software components Geographical data in computer: Data structures for GIS, Components of GIS- data acquisition, spatial and attribute data, pre-processing, storage and management; Data structures- raster and vector data; GIS analysis functions; Errors and corrections; Data presentation and generation of thematic maps. Introduction to QGIS software	
	5.2	GIS manipulation, query running, analysis and modelling, Errors and corrections	
	5.3	Civil Engineering Application of GIS	
6	**Hydrographic Survey**		4
	6.1	Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders	
	6.2	Civil Engineering Application of Hydrographic Survey	

Contribution to Outcomes

On completion of the course, the students will be able to:

- Select appropriate methods and instruments in surveying, based on accuracy and precision required, sophistication, availability of resources, economics and duration of project.
- Appreciate the superiority and leverage of using modern methods in surveying over conventional ones.
- Employ modern surveying methods, for solving complex surveying problems
- Apply different advance surveying methodologies to carry out large scale survey works as modern instruments have largely changed the approach to survey works with the principles being same.
- Collect and manipulate data using GIS for simplifying data management and also reducing labour.
- The knowledge of limits of accuracy will be obtained by making measurements with various surveying equipment employed in practice.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.

2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. The students will have to attempt **any three** questions out of remaining five questions.

5. Total **four** questions need to be solved.

Oral Examination:

The oral examination shall be based on the entire syllabus, the projects performed and practical conducted. It will include a practical exam (10 marks), before proceeding for viva (15 marks)

List of Practical:

1. Determination of co-ordinates of profile by GPS and length of profile.
2. Profile Leveling (Open Traverse) by Total Station and print output by using any software interface
3. Navigation of existing co-ordinates by GPS
4. Digitization work by any GIS software, like QGIS, ArcGIS, Gram++, etc.
5. Setting out a foundation plan of RC structure in the field using Total Station.

6. Mini Project on GIS using various software

Term work: It shall consist of the following:

1. **Mini Project** forming a group not less than 2 and more than 4 based on use of Geospatial tools for tackling problems on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.
2. Presentation on any one modern tool
3. Practical write up, clearly stating aims, objectives, sketches, observations, results and subsequent discussion of results
4. The assignments shall comprise at least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Mini-project: 05 Marks
- Report of the Experiments: 05 Marks
- Assignments: 05 Marks
- Presentation: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Study Materials

(A) Recommended Books:

1. Higher surveying: *A.M. Chandra*, New Age International publishers.

2. Higher surveying: *B.C. Punimia, Ashok Join, Arun K. Jain,* Laxmi Publications(P), Ltd.

3. Geographic Information System and Science: *Longley, Paul A., Michael F. Goodchild, David J. Maguuire, David W. Rhind*, John Wiley and Sons, New York (2nd Ed.), 2005

4. Modeling Our World: The ESRI Guide to Geodata base Design: *Zeiler, M.* ESRI Press, Redlands, California, 1999.

5. GIS, Spatial Analysis, and Modeling: Maguire, *D., M. Batty, and M. Goodchild* 2005. ESRI Press (070.212.05842005)

6. Global Positioning System: Signals, Measurements, and Performance, *Pratap Misra and Per Enge*(2nd Ed.), 2006.

7. Remote Sensing Principles and Interpretation*: Floyd, F. Sabins, Jr:, Freeman* and Co., San Franscisco,1978.

8. A Remote Sensing Perspective: Introductory Digital Image Processing: *John, R. Jensen*, Prentice Hall.

9. Imaging Radar for Resource Survey: Remote Sensing Applications: *W. Travelt*, Chapman and Hall.

10. Remote Sensing and GIS, *B Bhatia*, Oxford University Press, New Delhi.

11. Remote sensing and Image interpretation, *T.M Lilles, R.W Kiefer and J.W Chipman*, 5th edition, John Wiley and Sons India

12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. & Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002

13.Remote Sensing and Geographical Information Systems, *M. Anji Reddy*, B.S. Publications, Hyderabad, 2001

(B) Web Materials:

1. http://nptel.ac.in/courses/105104100/1
2. http://www.surveyofindia.gov.in/
3. http://www.iism.nic.in/
4. http://bhuvan.nrsc.gov.in/bhuvan_links.php
5. http://igrmaharashtra.gov.in/#

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5062	Department Level Optional Course-I: Advanced Concrete Technology	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. The concrete technology is the backbone of infrastructure of civil engineering field. The students must know various concreting operations and testing operations during and after construction. It is expected to know the properties of materials, especially concrete and to maintain quality in construction projects. The civil engineering students ought to know the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

This course mainly aims to develop the knowledge about properties/ design and testing of advanced cement concrete.

Expected Outcome: Upon completion of this course, the student will be able to

- Know the various materials and properties in concrete.
- Understand the various properties of special concrete
- Understand the Mix design by different methods.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability and cracking in concrete.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Properties of Concrete:**		5
	1.1	Cement and its types: general, hydration of cement, water requirement for hydration, alkali aggregate reaction. Aggregate: grading curves of aggregates.	
	1.2	Concrete: properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, curing and its method.	
2.	**Special Concrete:**		5
	Light weight concrete, ultra-light weight concrete, vacuum concrete, mass concrete, waste material-based concrete, shotcreting, guniting, sulphur concrete and sulphur infiltrated concrete, jet cement concrete (ultra-rapid hardening), gap graded concrete, no fines concrete, high strength concrete, high performance concrete.		
3.	**Concrete Mix Design:**		9
	3.1	Design of concrete mixes by IS code method - ACI method - Road Note No: 4 methods.	
	3.2	Design of high strength concrete mixes, design of light weight aggregate concrete mixes, design of fly-ash cement concrete mixes, design of high density concrete mixes.	
4.	**Fibre Reinforced Concrete:**		6
	Historical development of fibre reinforced concrete, properties of metallic fibre, polymeric fibres, carbon fibres, glass fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), basic concepts and mechanical properties: tension and bending.		
5.	**Testing of Concrete:**		8
	5.1	Properties of hardened FRC, behaviors under compression, tension and flexure of steel fibres and polymeric fibres.	

	5.2	Advanced non-destructive testing methods: ground penetration radar, probe penetration, pull out test, break off maturity method, stress wave propagation method, electrical/ magnetic methods, nuclear methods and infrared thermography, core test.	
6.	**Durability of Concrete:**		**6**
	Durability, Transport mechanism of fluids and gases in concrete, cracking in concrete - corrosion and carbonation induced cracking, Alkali Aggregate Reaction, degradation by freeze and thaw, chloride attack, sulphate and sea water attack (marine conditions). Hot and cold weather concreting.		
		Total	**39**

Contribution to Outcomes

On completion of the course, the students shall be able to:

- Know the various materials and properties in concrete.
- Understand the Mix design by different methods.
- Understand the various properties of special concrete.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability of concrete.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions out of remaining five questions.
5. Total **four** questions need to be attempted

Oral Examination:

The oral examination shall be based on the entire syllabus and experiments performed in the laboratory.

List of Practical (Any Eight to be performed):

1. Mix design in laboratory by ACI Method.
2. Mix design in laboratory by Road Note 4.
3. Chemical Admixture (Superplasticiser) optimization by Mini Slump and Marsh cone.
4. Concrete- Slump, Slump retention by Slump cone.
5. Split and Modulus of rupture of concrete.
6. Permeability test on concrete.
7. Rapid chloride penetration test
8. Tests on polymer modified concrete/mortar.
9. Tests on fiber-reinforced concrete.
10. Nondestructive testing of concrete- some applications (hammer, ultrasonic etc.).
11. Carbonation test on concrete.
12. Pull out/ pull off test on concrete.

Term Work: It shall consist of the following:

1. Neatly written report of afore mentioned experiments (at least eight)
2. Presentation on any emerging trend in concrete technology.
3. At least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 05 Marks
- Presentation: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Study Materials

(A) Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Relevant I.S. codes: Bureau of Indian standard.
5. Special Publication of ACI on Polymer concrete and FRC.
6. Proceedings of International Conferences on Polymer Concrete and FRC.
7. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
8. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
9. Chemistry of Cement and Concrete: F.M. Lue, Edward Arnold, 3rd Edition, 1970.
10. Concrete Technology: D.F. Orchardi, Wiley, 1962.
11. Tentative Guidelines for cement concrete mix design for pavements (IRC: 44-1976): Indian Road Congress, New Delhi.
12. Concrete mix proportioning-guidelines (IS 10262:2009).
13. Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999.
14. Concrete Mixture Proportioning- A Scientific Approach: De Larrard F., E&FN Spon, London, 1999.
15. Fibre Reinforced Cementitious Composites: ArnonBentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.

(B) Web Materials:

1. www.theconcreteportal.com
2. www.concrete.org

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5063	Department Level Optional Course-I: Building Services & Repairs	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Building service systems are complex. They are typically a major source of cost & potential coordination problems in building construction. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professional. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in building construction for an existing building to be in a good condition, so that it can continue to perform the intended functions, maintenance of the building plays a key role. Adequate maintenance improves aesthetic &functional values. Moreover; it facilitates extending the building life & ensures the safety of dwellers. Usually, the structures do perform well for about 50 years after the construction & thereafter, the deterioration begins. Insufficient maintenance & lack of repairs may lead to the limited life span of the structure. However, the regular maintenance & timely identification of deteriorated building elements for proper remedial measures may result in to the extension of life span of the structure up to 100 years also. The course deals with the building maintenance, special materials, concrete repair chemicals, strengthening of RCC members by underpinning, plate bonding, shoring, RC jacketing, etc. Technical knowhow and skills developed through this course may be helpful to preserve the historical buildings. Fire safety is to be studied in order to safeguard the building from fire damage.

Objectives

- To understand the concepts of building services & its applications.
- To understand design concepts of various machineries like lift, escalators, vibrators, concrete mixers, etc. & utility services in building like plumbing system, electrical system, etc.

- To get familiar with the causes of distress of concrete structures, seepage & leakage in concrete structures & the effect on steel corrosion.
- To study the condition survey, evaluation and assessment of damage through the visual inspection & various Non-Destructive Testing methods.
- To acquire the knowledge in connection with the special repair materials and crack repair methodologies to be applied in the field.
- To study the concrete protective materials, thermal protection coatings, etc. and implement the steel corrosion protection methods in the field.
- To study the fire safety of the structures.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Machineries**		05
	Lifts & Escalators- Special features required for physically handicapped & elderly, Conveyors, Vibrators, Concrete mixers, DC/AC motors, Generators, Laboratory services, Gas, Water, air & electricity, Hot water boilers and pumps		
2.	**Plumbing Systems & Fire safety in Building**		08
	2.1	Plumbing Services: Water Distribution system, Material for service pipes, Service connection, Size of service pipe, Water meter, valves and storage tanks.	
	2.2	Drainage system: Pipe and traps, system of plumbing, House drainage plans, septic tanks and soak pit.	
	2.3	Fire Safety Installation: Causes of fire in building - safety regulation - NBC - Planning considerations in building like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. system. Special features required for physically handicapped and elderly in building types - Heat and smoke detectors - Fire alarm system, snorkel Ladder - Fire Lighting pump and water storage - Dry and wet riser - Automatic sprinklers	

3.	**Electrical systems & Illumination Design in Buildings**		**07**
	3.1	Electrical systems in buildings: Basics of electricity - Single / Three phase supply, Protective devices in electrical installations, earthing for safety, Types of Earthing, ISI specifications, Types of wires, wiring systems &their choice, Planning electrical wiring for building, Main &distribution boards, Transformers & switch gears, Layout of substations	
	3.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Modern theory of light &colour, Synthesis of Light, Additive & Subtractive synthesis of colour, Luminous flux, candela, solid angle illumination, utilization factor, Depreciation factor, MSCP, MHCP, Lens of illumination, Classification of lighting, Artificial lights sources, spectral energy distribution, Luminous efficiency, colour temperature, colour rendering.	
	3.3	Design of Modern lighting: Lighting for stores, offices, school, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
4.	**Deterioration of Concrete Structures**		**05**
	4.1	Causes of deterioration of concrete structures, effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design& construction errors.	
	4.2	Causes of seepage & leakage in concrete structures. Formation of cracks including those due to corrosion.	
5.	**Condition Survey, Evaluation & Damage Assessment**		**05**
	5.1	Diagnostic methods & analysis.	
	5.2	Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity test, and crack measurement techniques, Concrete endoscopy & thermal imaging, pull-off test & pull-out test.	
6.	**Materials & Repair Methodologies, Protection of Concrete Structures & Rebar Corrosion Protection**		**09**

	6.1	Repair analysis & design.	
	6.2	Repair materials and their desired properties.	
	6.3	Methodologies for crack and patch repair: polymer modified mortar, polymer modified concrete, polymer concrete	
	6.4	Injection grouting, shotcrete, joints and sealants, rebar corrosion crack repair 10.5	
	6.5	Protective materials and their properties for moisture barrier systems.	
	6.6	Above grade and below grade water-proofing of concrete structures.	
	6.7	Systems like integral, crystalline, coatings, membranes, etc.	
	6.8	Thermal protection coatings.	
	6.9	Methods of corrosion protection, corrosion inhibitors	
	6.10	Corrosion resistant steels, cathodic protection	
	6.11	Pre-packed zinc sacrificial anode, Snap-on zinc mesh anode CP system.	
		Total	**39**

Contribution to Outcomes

On successful completion of the course, it is expected that the course will enable the students to:

- Understand the importance & installation of utility services.
- Understand the drawbacks of all the service lines are not installed properly or if materials used are faulty.
- Choose appropriate systems & integrate the same into the building construction projects.
- Assess the structural health of the buildings & infrastructural works and also Inspect & evaluate the damaged structures.
- Implement the techniques for repairing the concrete structures and also decide whether or not the structure should be dismantled, if it is deteriorated beyond repair.
- Employ the methods of steel protection in the field.
- Understand the damage caused by fire & exercise due care for fire safety.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory.** It will have short questions, each carrying 4 to 5 marks, covering the entire syllabus.

3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents, thereof.
4. There can be options within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus & the term work consisting of the assignments& experiments.

List of Practicals:

1. Carbonation test by spraying phenolphthalein
2. Non -destructive testing of concrete structures by Rebound hammer.
3. Non -destructive testing of concrete structures by UPV meter.
4. Outdoor exposure test to measure weathering of coating
5. Test for flexibility of coating by applying on a tin sheet
6. Test for effectiveness by measuring water absorption of coating applied on a card board.

Condition Survey:

The students will carry out the condition survey of any damaged structure by visual observations& will prepare a detailed report thereof. This report will form a part of the term work.

Term Work:

The term-work shall comprise of the neatly written report based on the experiments/ practical performed & the assignments along with the detailed report on the condition survey.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon its quality. The final certification and acceptance of the term work warrants the satisfactory performance of the experiments/ practical by the student, properly compiled report thereof along with the assignments and the report on condition survey & the minimum passing marks to be obtained by the student. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ questions on each sub-modules & contents thereof further. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Report on the Condition Survey: 04 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks 81%- 90%: 04 Marks 91% onwards: 05 Marks.

Recommended Books:

1. Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968.
2. Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
3. Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4. The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
5. National Building Code.
6. Building Construction: *Dr. B. C. Punmia, Ashok K Jain*, A.K Jain
7. Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
8. Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi
9. Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication.
10. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
11. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
12. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf.
13. Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.
14. Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis Publication.
15. Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.

16. Testing of Concrete in Structures: *John H. Bungey, Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
17. Durability of concrete and Cement Composites: *Page, C.L.*and Page, *M.M.,* Woodhead Publishers
18. Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5064	Department Level Optional Course-I: **Advanced Structural Mechanics**	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

- To understand the concept of shear centre& evaluate the shear centre for symmetrical & un-symmetrical thin walled sections.
- To understand the concept &behavior of beams resting on elastic foundation.
- To study the behavior of beams curved in plan.
- To understand the concept of different theories of failure in regards of materials.
- To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Shear centre:**		5
	Shear Centre for symmetrical & unsymmetrical (about both axes) thin walled open sections.		
2	**Bending of beams with large initial curvature:**		8
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	**Beams on elastic foundation:**		8
	3.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	3.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
4	**Beams curved in plan:**		5
	4.1	Analysis of beams loaded perpendicular to their own plane.	
	4.2	Simply supported, fixed & continuous beams.	
5	**Theories of Failure:**		7
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	**Analysis of deep beams:**		6
	6.1	Determination of deflection	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
	6.3	Stress concentration, stress concentration factor.	
		Total	**39**

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

- Understand the concept of shear centre for thin walled open sections.
- Study the behavior of beam resting on elastic foundation with various loading conditions.
- Analyze the beam curved in plan for different support conditions.
- Understand the concept of different theories of failure in different sections.
- Determine deflection, shear correction factor for different sections like solid & hollow sections.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying **20** marks.
2. The **first** question will be **compulsory**, which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt **any three** questions out of **remaining five** questions.
6. Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report based on the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof further.

Oral Examination:

The oral examination shall be based upon the entire syllabus & the term work.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Mechanics of Materials: Popov, E.P. Prentice Hall of India Pvt. Ltd.
2. Mechanics of Materials: James Gere, M., Thomson Brooks.
3. Mechanics of Materials: Beer, F.P., E. Russell Jhonston and John T. DeWolf, TMH, New Delhi.
4. Advanced Mechanics of Materials: Arthur P. Boresi and Omar M. Sidebottom, Wiley and Sons.
5. Advanced Mechanics of Materials: Arthur P. Boresi and Richard Schmidt, John Wiley and sons.
6. Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
7. Mechanics of Solids: Shames, I and Pitarresi, J. M., Preentice Hall, New Delhi.
8. Beams on Elastic Foundation: Heteny M. 9. Strength of Materials: Subramanian, Oxford University Press.

Semester V

Subject Code	Subject Name	Credits
CE507	**Business and Communication Ethics**	**2**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	**4#**	-	-	**2**	-	2

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	50	-	-	50

Rationale

Ethical issues of **Business Communication** are the process by which individuals exchange information between other individuals or groups of people. Throughout the process, effective communicators try as clearly and accurately to convey their thoughts, intentions and, objectives to their receiver. This course is very important for aspiring Civil Engineers as the industry suffers major delays due to miscommunication between various parties to the contract.

Objectives

- To inculcate professional and ethical attitude.
- To enhance effective communication and interpersonal skills.
- To build multidisciplinary approach towards all life tasks.

Detailed Syllabus

Module	**Sub-Modules/ Contents**		**Periods**
1	**Report Writing**		**05**
	1.1	Objectives of Report Writing	
	1.2	Language and Style in a report	
	1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	

2	**Technical Writing**		**03**
	2.1	Technical Paper Writing (ASCE Format)	
	2.2	Proposal Writing	
3	**Introduction to Interpersonal Skills**		**09**
	3.1	Emotional Intelligence	
	3.2	Leadership and Motivation	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution and Negotiation Skills	
	3.6	Time Management	
	3.7	Decision Making	
4	**Meetings & Documentations**		**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice, Agenda and Minutes of a meeting	
	4.3	Business meeting etiquettes	
5	**Introduction to Corporate Ethics**		**02**
	5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
	5.2	Introduction to Intellectual Property Rights	
	5.3	Ethical codes of conduct in business and corporate activities(Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
6	**Employment Skills**		**07**
	6.1	Group Discussion	
	6.2	Resume Writing	
	6.3	Interview Skills	
	6.4	Presentation Skills	
	6.5	Statement of Purpose	
		Total	**28**

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Term Work:

The term-work shall comprise of the neatly written report based on the Assignments, Project Report Presentation and Group Discussion. The assignments shall be given according to the list given below

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate

completion of the assignments and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work. Term work will consist of all assignments from the list. The distribution of marks for term
Work will be as follows:

- Book Report: 10 Marks
- Assignments:10 Marks
- Project Report Presentation: 15 Marks
- Group Discussion:10 Marks
- Attendance:05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Fred Luthans, *"Organizational Behavior"*, McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business"*, McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication"*, McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work"*, Thomson Learning, 12th edition
5. Heta Murphy, *"Effective Business Communication"*, Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing"*, Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development"*, Tata McGraw Hill.
8. Lehman, Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Semester VI

Semester VI

Subject Code	Subject Name	Credits
CEC601	**Geotechnical Engineering-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	**3**	1	-	**4**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	**25**	**150**

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers; and more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative business and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

- Students will gain knowledge of consolidation theory.
- Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.
- Students will analyze stability of slopes, comprehend lateral earth pressure theories and apply them in stability analysis of retaining walls.
- Students will analyze and design shallow as well as deep foundations.
- Students will gain knowledge of underground conduits and braced cuts.
- Students will gain knowledge of ground improvement techniques.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Consolidation of soils**		04
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion recompression indices, normally over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	**Shear strength**		05
	2.1	Introduction, three dimensional state of stress in soil mass, principal stresses in soil, shear failure in soils- frictional cohesive strength, general shear stress-strain curves in soil definition of failure, graphical method of determination of stresses on a plane inclined to the principal planes through Mohr's circle, important characteristics of Mohr's circle.	
	2.2	Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure criterion- relation between major minor principle stresses, total & effective stress analysis.	
	2.3	Different types of shear tests drainage conditions; Direct shear test, Triaxial compression test (UU, CU CD), Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves Mohr failure envelopes	
	2.4	Determination of shear strength of soil with geosynthetics- pull out test: ASTM procedure for finding shear strength of soil-geosynthetic system.	

3.	**Stability of Slopes**		04
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage along the slope	
	3.3	Stability analysis of finite slopes: i) Culmann's method, ii) Swedish slip circle method, iii) friction circle method and iv) Taylor's stability number	
4.	**Lateral Earth Pressure Theories and Stability of Retaining Walls**		10
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine's earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb's wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann's Graphical Method (no proof)	
	4.5	Culmann's Graphical Method (no proof)	
	4.6	Introduction to retaining walls: types of retaining walls, stability checks for retaining walls	
	4.7	Stability analysis of gravity retaining walls	
	4.8	Stability analysis of cantilever retaining walls	
5.	**Shallow Foundations**		10
	5.1	Introduction: types of shallow foundations, definitions of different bearing capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi's theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi's theory ii) Vesic's theory: bearing capacity equation	

		iii) I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6.	**Pile Foundations**		**6**
	6.1	Introduction to pile foundations: types of pile foundations, necessity of pile foundations	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
		Total	**39**

Contribution to Outcomes

- Students will be able to evaluate the consolidation parameters for the soil.
- Students will be able to calculate the shear strength parameters for the soil.
- Students will be able to calculate the factors of safety of different types of slopes under various soil conditions, analyze the stability of slopes, calculate lateral earth pressures and analyse the stability of retaining walls.
- Students will be able to calculate bearing capacity of shallow foundations using theoretical and field methods, calculate load bearing capacity of individual as well as group of pile foundations and their settlement using theoretical and field methods
- Students will be able to explain conduits and calculate the load carried by the struts of a braced cut under various soil conditions.
- Students will be able to explain ground improvement techniques.

Theory Examination

1. Question paper will consist of total **6** questions; each carrying 20 marks.
2. Only **4** questions (out of 6) need to be attempted.
3. Question no. **1** will be **compulsory.**

4. Any **3** out of the remaining **5** questions need to be attempted.
5. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Oral Examination:

The oral examination shall be based upon the entire syllabus

Term Work:

Although it is recommended that 7 experiments are desirable, at least 5 should be performed.

1. Determination of pre-consolidation pressure coefficient of consolidation from one dimensional consolidation test.
2. Determination of shear parameters form unconsolidated undrained tri-axial compression test
3. Determination of shear parameters from direct shear test
4. Determination of cohesion from unconfined compression test
5. Determination of CBR value from CBR test
6. Determination of shear strength of soft clays from vane shear test.
7. Determination of swelling pressure of clays

Assignments:

a) Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on GROUND IMPROVEMENT TECHNIQUES. The teacher is expected to deliver extra lectures on the topic, thereby imparting the knowledge to the students, about the concept of ground improvement. The questions related to ground improvement techniques shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Reinforced earth: Design of reinforced earth wall
- Geotextiles: definition, types, functions and use in civil engineering

- Introduction to stone columns and prefabricated vertical drains

Distribution of Term Work Marks

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications
2. Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors
3. Soil Mechanics and Foundation Engineering: V. N. S. Murthy; Saitech Publications
4. Geotechnical Engineering: C. Venkatramaiah; New Age International
5. Soil Engineering in Theory and Practice: Alam Singh; CBS Publishers Distributors
6. Designing with Geosynthetics: R. M. Koerner; Prentice Hall, New Jersey
7. An Introduction to Soil Reinforcement Geosynthetics: G. L. Sivakumar Babu; Universities Press
8. Theoretical Soil Mechanics: K. Terzaghi; John Wiley and Sons
9. Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and Sons.
10. Relevant Indian Standard Specifications Code: BIS Publications, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC602	**Design and Drawing of Steel Structures**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	**4**	1	-	**5**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	25	---	25@	150

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. IS code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

- To make students familiar with behavior of steel structure and their components under the action of various loads.
- To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
- To equip students with aspects required for designing tension member, compression members and column bases.
- To equip students with aspects required for designing beams and welded plate girder
- To help students design connections in steel members
- To aid students in designing steel trusses.

Detailed Syllabus

Module	Sub Modules/Contents		Periods
1.	**Introduction**		**04**
	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Design Requirements & Design Process, Advantages and limitations of WSM, Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.		
2.	**Design of tension members**		**06**
	Introduction, types of tension members, net area calculation. Design strength due to yielding, rupture and block shear. Design of tension members with welded and bolted end connection using single angle section & double angle section.		
3.	**Design of compression members and column bases**		**15**
	3.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	3.2	Design of axially loaded column using rolled steel sections, design of built up column, laced and battened Columns.	
	3.3	Design of slab bases & gusseted base.	
4.	**Design of beams and welded plate girder**		**13**
	4.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection. Design of angle section purlin.	
	4.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment, stiffeners and connections	
5.	**Design of connections**		**07**
	Design of bolted and welded beam to beam and beam to column connections.		

	Framed, stiffened and unstiffened seat, bracket connections.	
6.	**Design of truss**	**07**
	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing.	
	Total	**52**

Contribution to Outcomes

On completion of this course, the students will be able to:

- Explain the Limit State Design philosophy as applied to steel structures.
- Predict the behavior and design members subjected to axial compression, tension and their connection.
- Predict the behavior and design members subjected to bending, shear and their connection
- Calculate loading for a truss and design the complete truss.
- Demonstrate ability to follow IS codes, design tables and aids in analysis and design steel structures.
- Analyze and design the commercial steel structures and prepare drawing with complete detailing.

Theory examination:

1. Question paper will comprise of five questions. First question will **carry 32** marks and remaining four will carry **16 marks** each. The **first** question will be **compulsory.** From remaining four questions any **three** questions can be answered. Total **four** questions need be attempted.
2. The **first** question will be based on **any one** of design projects from following.

a) Design of Truss.

b) Design of flooring system.

3. The next four questions will be based on remaining modules of syllabus. The weightage of the marks shall be judiciously awarded in proportion to the importance of the module and number of hours allotted for the module. There can be an internal choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
4. For each question, the drawings will carry 20% weight of respective question. Drawings of questions **shall be drawn on half imperial drawing sheet** during the examination. The drawings of remaining questions may be drawn on drawing sheet or answer book.

5. All relevant IS codes will be allowed during examination.

Oral Examination:

The oral examination shall be conducted in conjunction with the sketching examination and it will be based upon the entire syllabus and the term work consisting of the assignments, projects including drawing sheets.

Term Work:

The Term work shall consist of following:

1. Design Report including detail drawings on any of the two projects as listed below:
   a) Design of truss (internal forces to be calculated by analytical method/graphical method/using any software)
   b) Flooring system including beam, column, column base and connections.
   c) Welded plate girder.

The drawing should be drawn in pencil only on minimum of A-1(imperial) size drawing sheets.

2. Neatly drawn minimum 15 sketches showing structural detailing based on entire syllabus(in sketchbook).
3. Neatly written assignments covering the syllabus. (At least four problems on each modules and contents thereof)
4. One site visit report (The report should contain structural details with sketches).viz. Industrial structure, Railway Structures, Workshops etc.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the design report, drawing work and assignments and minimum passing marks obtained by student. The following weightage of marks shall be given for different components of the term work.

Design Report:	05 Marks
Drawing sheets:	10 marks
Assignments:	05 Marks
Attendance:	05 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2. Limit state design of steel structures by S. K. Duggal, McGraw Hill Education(India) Pvt. Limited, New Delhi.
3. Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi
4. Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5. Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
6. Relevant Indian Specifications, Bureau of Indian Standards, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC603	**Transportation Engineering-II**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways railways. This course is developed so as to impart the basic principles behind railway engineering, airport engineering water transportation engineering in respect of their various types of materials used, function of component parts, methods of construction, planning principles, aspects of supervision maintenance.

Objectives

- To enable the students to study the various elements pertaining to air transportation, water transportation, railway transportation. To study the various components of railway track, materials used functions of component parts.
- To study the various imaginary surfaces of an airport, geometric standards, runway taxiway lighting.
- To study the various parking system, holding apron, hangars drainage system.
- To study the various modes of water transportation, types of breakwater, harbours and port facilities equipment.
- To study the various aspects of jetties, wharves, piers, dolphins, fenders buoyancy etc.
- To study the fundamental concepts of bridge engineering

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	General Introduction: Role of transportation in Society, objectives of transportation system, different types of modes, planning coordination of different modes for Indian conditions.		10
	Railway Engineering		
	1.1	Railways for urban transportation-Engineering surveys for track alignment-Obligatory Points-Conventional and modern methods (eg. Remote sensing, GIS)	
	1.2	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials.	
	1.3	Rails: coning of wheels, tilting of rails, rail cross sections, wear, creep of rails, rail fastenings.	
	1.4	Yards: details of different types of railway yards their functions.	
	1.5	Construction and maintenance of railway track, methods of construction, material requirements, maintenance of tracks, traffic operations.	
	1.6	Modernization of track and railway station for high speed trains, Mono rails and Metro rails.	
	1.7	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions, different ballast materials.	
2.	**Geometric Design of Railway and Traffic Control**		08
	2.1	Geometrics: gradients, transition curves, widening of gauge on curves, Cant deficiency.	
	2.2	Points crossing: design of turnouts, description of track junctions, different types of track junctions.	
	2.3	Signaling interlocking: classification of signals, interlocking of signals points, control of train movement.	

3.		**Airport Engineering**	**08**
	3.1	Aircraft component, their functions, aircraft characteristics and their influence on airport planning.	
	3.2	Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors affecting airport site selection.	
	3.3	Airport obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones.	
	3.4	Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers parking.	
	3.5	Airport marking and lighting marking, lighting of runways, taxiway, approach other areas.	
	3.6	Terminal area & airport layout: terminal area, planning of terminal buildings, apron: size of gate position, number of gate position, aircraft parking system, hanger, general planning considerations, blast considerations.	
4.		**Air Traffic Control**	**06**
	4.1	Air traffic control aids, en-route aids, landing aids.	
	4.2	Airport drainage: requirement of airport drainage, design data, surface drainage design.	
	4.3	Airport airside capacity delay: runway capacity delays, practical hourly capacity, practical annual capacity, computation of runway system, runway gate capacity, taxiway capacity,	
	4.4	Air traffic forecasting in aviation: forecasting methods, forecasting requirement applications.	
5.		**Water Transportation**	**03**
		Introduction of water transportation system, harbors docks, port facilities.	
6.		**Bridge Engineering**	**04**
		Bridge Engineering: Importance, Investigations, Site Selection, Different terms related with Bridges; Waterway, Afflux, Economic span, Scour depth,	

	Different types of bridges: Superstructures and sub-structures, Different loadings for design of bridges, Design requirements for high speed trains	
	Total	**39**

Contribution to Outcomes

On successful completion of this course, the students shall be able to:

- Understand the various systems of railway, airport, water transportation and the components of p-way and its construction, yards, modernization of railway track.
- Apply the concept of geometric design of railway track and railway traffic control.
- Understand airport planning, obstructions and orientation of runway.
- Apply the concept of geometric design of runway, taxiway, etc. and the knowledge of various signaling system for air traffic control.
- Understand the system of water transportation, types of breakwater, harbours and port facilities equipment
- Understand the basic idea about the bridge engineering.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. There can be an **internal** choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-module content thereof further. There shall be theory questions as well.

Distribution of Term-work Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. A Course of Railway Engineering: *Saxena, S. C. and Arora, S. P.*; Dhanpat Rai Sons, New Delhi.
2. Airport Planning Design: *Khanna, S.K., Arora, M.G.and Jain, J.J.; Nemchand Bros., Roorkee.*
3. Docks and Harbour Engineering: *Bindra, S. P.*; Dhanpat Rai and Sons, New Delhi.
4. Principles and Practice of Bridge Engineering: *Bindra, S.P.;*Dhanpat Rai and Sons, New Delhi.
5. Harbour, Dock and Tunnel Engineering: *Shrinivas, R.;*Charotar Publishing House, Anand
6. A Text Book on Highway Engineering Airports:-Sehgal, S. E. and Bhanot, K. L., S. Chand and Co. Ltd., New Delhi
7. Airport Engineering: *Rao, G. V.*, Tata Mc-Graw Hill India Publishing House, New Delhi

Reference Books:

1. Indian Railway Track: *Agarwal, M. M.*,Suchdeva Press New Delhi.
2. Planning Design of Airport: *HoronjeffMckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
3. Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House
4. Bridge Engineering: Victor, D. J., Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi
5. Bridge Engineering: *Bindra, S. P.*, Dhanpatrai and Sons, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CE-C604	Environmental Engineering – II	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	**02**	--	**03**	**01**	--	**04**

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**03**	**25**	--	**25**	**150**

Rationale

Environment has gained increasing importance in the relation with the principles of public health engineering, design of waste water collection and treatment systems; and develops rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of sewage processes and solid waste management. The course lays emphasis on complete update of the knowledge of these processes related to design of treatment plant.

Objectives

- To understand and explain the role of sanitation and its relation to public health and environment.
- To provide knowledge of wastewater collection system, characteristics of wastewater.
- To provide students the necessary knowledge and concepts of advancements/emerging techniques of treatment in physical, chemical and biological treatment processes. To provide students prerequisite knowledge necessary for higher studies and research in the field of wastewater treatment.
- To study the appropriate treatment, reclamation and resource recovery and re-use at both centralized and decentralized levels. Also, to study self-purification in nature.
- To develop rational approaches towards sustainable wastewater management via sludge recovery and treatments.
- To provide necessary skill for understanding and operation of solid waste management facilities.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Sewage Generation, Collection and Conveyance**		10
	1.1	**Introduction**: Need for sewerage system, Domestic sewage, Industrial waste and Storm Water, Conservancy and water carriage system, Systems of sewerage and their layouts: Separate, Combined and partially combined system, Merits and demerits, Patterns of sewerage layout, Quantity of sewage	
	1.2	**House drainage and Environmental sanitation** **Plumbing:** basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Systems of Plumbing, anti-siphonic and vent pipes.	
	1.3	**Conveyance of sewage** Sewer: Shapes and materials of sewers, open drains, Design of sewers: sewer size, Determination of velocity of flow using empirical formulae, limiting velocities. Laying and testing of sewers, Sewer joints, Sewer appurtenances, Ventilation of sewers. Construction and Maintenance of sewers. Pumping of sewage: Pumping station components	
2.	**Characterization and Primary Treatment of sewage**		07
	2.1	Need for Analysis, Characteristics of sewage: Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition, Sampling of sewage, Analysis of sewage. Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
3.	**Conventional Biological treatments**		11
	3.1	**Secondary Treatment Methods** Trickling filter- Principle, Process description and Operational problems and Design. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, Operational problems, Sludge volume index and	

		Design of ASP. Aerated lagoons- Process description and Design, Rotating Biological contractors, Stabilization Ponds, UASB.	
	3.2	**Constructed Wetland** Wetland and aquatic treatment systems; Types, application, Treatment Free water surface and subsurface constructed wetlands, Other aquatic treatment systems- Root zone technology, Duckweed ponds	
	3.3	**Septic Tank and Soak Pit** –Operation, suitability and Design. Concepts of advances in wastewater treatment. Imhoff Tank On-site treatment: Meaning of decentralized treatment.	
4.	**Reclamation and Reuse of Waste water**		**05**
	4.1	Tertiary and Grey water treatment, recycling and reuse of wastewater.	
	4.2	**Self-Purification of Natural Water Bodies** Oxygen economy, Sewage farming. Disposal of treated effluent Disposal of Raw and treated sewage on land and water, standards for disposal. Stream pollution: Self-purification, DO sag curve.	
5.	**Sludge Treatment and Disposal**		**03**
	5.1	Thickening, Dewatering, Sludge Digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks. Disposal- disposal of digested sludge, drying beds.	
6.	**Municipal Solid Waste Management**		**03**
	6.1	Solid waste: Sources, Types, generation and collection, storage, handling, transportation, processing, treatment and disposal methods Introduction to Hazardous wastes, E-wastes and Plastic wastes.	
		Total	**39**

Contribution to Outcomes

Having completed this course, the students shall ensure the safe handling and treatment of wastewater and sewage. The students shall be able to conduct quality control tests on samples obtained from sewer water, soil, nearby rivers and groundwater. The students shall be able to design the treatment facilities and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in most effective manner.

After the completion of the course the student should be able to:

- Explain wastewater collection systems in buildings and municipal areas and to determine the quantity of wastewater and storm water production. Also, gain the knowledge of the construction of new sewer line and importance of sewer appurtenances.
- Explain and analyze the characteristics of wastewater and design the primary treatment for wastewater
- Explain on-site treatment methods and solve Analyze and design wastewater treatment systems (ASP, Aerated lagoon and Oxidation ponds).
- Identify and apply proper treatment for reclamation and reuse of wastewater and disposal.
- Explain sludge characteristics and processing methods.
- To provide knowledge of solid waste collection system, characteristics of solid waste and to identify hazardous waste. Study related to plastic waste management will be studied.

Theory examination:

1. Question paper will comprise of **Six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total **four** questions need to be attempted.

List of Practical:(Any eight to be performed)

1. Determination of pH of sewage.
2. Determination of Chlorides.
3. Determination of Total Solids, suspended solids, dissolved solids, volatile solids.
4. Determination of Oil and Grease in waste water.
5. Determination of Dissolved oxygen.
6. Determination of Bio Chemical Oxygen Demand of sewage sample.
7. Determination of Chemical Oxygen Demand of sewage sample.

8. To find Sludge Volume Index (SVI) of sewage sample.
9. Plumbing demonstration of accessories, fittings and fixtures.
10. Solid waste: Determination of pH.
11. Solid waste: Determination of moisture content.

Term work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory along with the assignments. A brief report on the visit to sewage treatment plant shall also form a part of the term work.

Site Visit:

The student should visit to sewage treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

Mini Project :(Any one)

1. Identify sewer network of a particular area and study the case.
2. Collect the sample from municipal or industrial wastewater, test the parameters and suggest the treatment.
3. Identify the sewerage treatment facility in your area and suggest modification, innovation with design.
4. Identify plumbing system. Enlist sewer appurtenances and system requirement for row house or apartment.
5. A case study related to solid waste management or any waste minimization technique.
6. Model making in form of prototype with respect to sewage treatment or solid waste management.
7. Design of sewage treatment plant using software.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the site visit and the minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

The following weightage of marks shall be given for different components of the term work.

- Internal Oral examination based on Experiments and Assignments: 10 Marks

- Mini Project: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%; 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Oral Examination

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Recommended Books

1. Wastewater Engineering- Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
2. Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
3. Environmental Engineering: *Peavy, H.S., RoweD.R., Tchobanoglous G.*; 1991, Tata-Mcgraw Hill.
4. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: *S. K. Garg*, Khanna Publishers New Delhi.
5. Water supply and sanitary Engineering: *Hussain S. K.*; Oxford and IBH Publication, New Delhi.
6. Plumbing Engineering, Theory and Practice: *Patil S. M.*, Seema Publication, Mumbai.
7. CPHEEO Manual on Sewage and Treatment.
8. Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
9. Relevant Indian standard specifications and BIS publications.
10. Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
11. Integrated solid waste management, Tchobanoglous, Theissen and Vigil, McGraw Hill Publication.
12. Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.
13. Water Supply and Sewerage: *E.W. Steel.*
14. Introduction to Environmental Engineering, *Vesilind*, PWS Publishing Company 2000.
15. Introduction to Environmental Engineering: P. *AarneVesilind*, *Susan M. Morgan*, Thompson.
16. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.

Semester VI

Subject Code	Subject Name	Credits
CEC605	Water Resources Engineering-I	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3	25	-	25	150

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This subject provides necessary knowledge about various irrigation methods based on crop water requirements, hydrologic processes, estimation of storage capacity of reservoir and hydraulics of wells.

Objectives

- To study various types of irrigation projects.
- To study and understand the various techniques and methods of irrigation.
- To understand the irrigation requirements of crops.
- To calculate storage capacity of reservoirs.
- To study the elements of hydrologic cycle and calculate catchment yield.
- To study the hydraulics of wells and ground water exploration methods.

Detailed Syllabus

Module	**Sub-Modules/ Contents**	**Periods**
1.	**Introduction:**	**6**
	Definition of irrigation, water resources in India, development of irrigation in India, need of irrigation in India, Benefits of irrigation, ill effects of irrigation, irrigation systems: major, medium and minor irrigation projects, command area	

	development, impact of irrigation on environment, national water policy.	
2.	**Irrigation methods and management**	**6**
	Types of irrigation: surface irrigation, subsurface irrigation; lift irrigation, bandhara irrigation, percolation tanks. Techniques of water distribution: free flooding, border flooding, check flooding, basin flooding, furrow irrigation method, micro irrigation, sprinkler irrigation, drip irrigation. Irrigation scheduling, participatory irrigation management.	
3.	**Water requirement of crops:**	**7**
	Crops and crop seasons in India, cropping pattern, duty and delta, quality of irrigation water, soil water relationship, soil characteristics significance from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation, water requirement and capacity of canal and reservoir, assessment of irrigation water, water conservation, rain water harvesting.	
4.	**Hydrology**	**8**
	Hydrologic cycle, Precipitation: Types of precipitations, measurement of rainfall by rain gauges, stream flow measurement, runoff, factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, runoff computations, flood discharge and calculations, unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph, complex hydrograph.	
5.	**Ground water and well hydraulics:**	**6**
	Ground water resources, occurrence of ground water, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	
6.	**Investigation and reservoir planning**	**6**
	Selection of site for reservoir, zones of storage reservoir, capacity elevation and area elevation curve of reservoir site, control levels, fixation of control levels, reservoir sedimentation, methods of control of sedimentation, evaporation loss, estimation and controlling methods of evaporation.	
	Total	**39**

Contribution to Outcomes

On completion of this course the student will be able to:

- Classify various types of irrigation projects
- Explain different irrigation methods and effective use of water resources.
- Calculate the crop water requirements and irrigation requirement.
- Derive hydrographs and calculate runoff of a catchment area.
- Explain the steady state and unsteady state conditions of any aquifer and design water wells.
- Estimate the capacity of a reservoir for different purposes.

Theory Examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions out of remaining five questions.
5. Total **four** questions need to be solved.

Oral Examination:

The oral examinations shall be based on the entire syllabus including term work.

Term Work:

The term work shall comprise of the neatly written assignment/tutorials based on above modules. The assignment shall be covering the entire syllabus in such way that the student would attempt at-least three questions including numerical if any, on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance in tutorials and appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks

- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Irrigation and Water Power Engineering: *B.C. Punmia, Pande B.B. Lal, A.K Jain.* Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
3. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,* Ane Books Pvt. Ltd.ISBN, 9789383656899.
4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.
6. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand.
7. Engineering for Dams, Vol. I to III:*Crager, Justin and Hinds*, John Wiley.
8. Design of Small Dams: USBR.
9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross.
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6061	Department Level Optional Course-II-Advanced Construction Equipment	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	2	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Machines have revolutionised every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods used to construct facilities using modern equipment. It further exposes the student to different kinds of civil engineering structures which they are supposed to construct in the field and makes them aware with the equipment required for the same. The impact of use of equipment on human resource as well as how equipment will help in making optimum utilization of resources is also given a thought.

Objectives

- To illustrate the characteristics and complexities involved in large civil engineering projects.
- To classify various construction equipment
- To elaborate the various advanced equipment used on, below or above ground/water.
- To discuss about the various non-conventional construction techniques which make use of these advanced equipment.
- To discuss the utility of modern formworks systems over conventional systems.
- To select appropriate equipment and techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources etc.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction**		06
	Study of Different categories of construction equipment used conventionally with reference to available types and their capacities, operations and factors affecting their performance.		
	1.1	Earthmoving and other hauling equipment	
	1.2	Drilling and blasting equipment.	
	1.3	Pile driving equipment.	
	1.4	Pumping equipment (for water as well as concrete), Applications of Air compressor.	
	1.5	Dewatering techniques for trenches, tunnels.	
	1.6	Stone crushing equipment.	
2.	**Equipment for Underground and Underwater tunneling.**		09
	Various purposes for which tunneling may be carried out, Basic terms related to tunneling, Conventional methods of carrying out tunneling in different types of soils/rocks. Modern methods of tunneling and detailed study of following equipment/techniques in this regard:		
	2.1	Jumbo – used for drilling and blasting.	
	2.2	Vertical shaft sinking machine (VSM).	
	2.3	Tunnel Boring machine (TBM), Micro tunneling.	
	2.4	New Austrian tunneling method (NATM).	
	2.5	Cut & cover method, Top to bottom construction.	
	2.6	Tunnel lining trolley.	
3.	**Modern formwork systems**		06
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages.	
	3.2	Modular shuttering, Slip and jump form, Tower cranes and the benefits they offer for high rise construction.	
	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems.	
	Equipment for construction of underground utilities, road construction		

4.	**and bridges/flyovers**		**06**
	4.1	Pipeline insertion system, use of ground penetrating radar (GPR) for locating underground utilities.	
	4.2	Construction of roads using paver machines.	
	4.3	Methods of construction for bridges/flyovers and the processes/equipment required thereof, Incremental launching method and balanced cantilever method with reference to the recent infrastructure developed in the local and global context.	
5.	**Equipment/ techniques for setting up of power generation structures.**		**06**
	5.1	Hydropower station.	
	5.2	Thermal power station.	
	5.3	Solar power station.	
	5.4	Atomic power generation.	
	5.5	Installation and operation of wind mills.	
	5.6	Installation and operation of underground power transmission lines as well as overhead transmission towers.	
6.	**Equipment for construction of transporting facilities**		**06**
	4.4	Construction of railway lines using track laying machine. Methods, techniques and equipment involved in the construction of Metro, mono and maglev trains. Special requirements of the permanent way in each case.	
	4.5	Equipment required for construction and operation of an airport and sea port.	
		Total	**39**

Contribution to Outcomes

On successful completion of this course, students shall be able to:

- Understand the use/applications of various conventional construction equipment and select the best out of them for a particular site requirement.
- Know modern methods/equipment used for underground as well as underwater tunnelling.
- Compare conventional and modern methods of formwork on the basis of productivity, reuse value, ease of erection and dismantling, flexibility offered and overall cost.

- Understand the techniques involved and the equipment required thereof for construction of various transporting facilities.
- Gain knowledge about the setting up of different kinds of the power generating structures.
- Select proper equipment for construction of transporting facilities based on requirements.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory which the short questions will have having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term work shall comprise of the neatly written report based on assignments (One for each module) and site visits (minimum 2). The assignments shall be given covering the entire syllabus and preferably different questions can be given to different group of students so that they themselves will create the question bank and answers for the same.

This course should be taught through maximum site visits and demonstration of the working processes and equipment through animations/videos to make the delivery most effective. The difference between conventional and modern method of carrying out a construction process should be clearly known to the students. Site visits to various ongoing infra projects especially in Mumbai Metropolitan region (MMR) can be of great help to the students. The site visits should be planned in such a way so that maximum equipment/techniques can be seen actually by the students. The report on site visit shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report on Site Visits: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books/Study material:

1. Construction Equipment & Planning, Purifoy, R.L & Ledbetter, McGraw Hill
2. Construction Equipment & it's Management, Sharma, S. C. Khanna Publishers
3. Tunnel Engineering Handbook, Thomas R. Kuesel, Elwyn H. King, John O. Bickel, Springer
4. Practical tunnel construction, Gary B. Hemphill, Wiley Publishers.
5. Construction Technology for Tall Buildings, Michael Yit Lin Chew, World Scientific
6. The prefabricated home, Colin Davies, Reaktion Books.
7. Literature/specifications/downloadable videos available on Doka and Mivan shuttering websites.
8. Accelerated Bridge Construction: Best Practices and Techniques, Mohiuddin Ali Khan, BH Elsevier
9. Design and Construction of Nuclear Power Plants, RüdigerMeiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6062	Department Level Optional Course-II-Traffic Engineering and Management	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Transportation Planning is a backbone of the urban planning or town planning. It constitutes the important part of any urban or town system. Traffic Engineering follows the Transportation Planning and is the specialized branch of the Highway Engineering which deals with the improvement of traffic performance on road network and terminals through systematic traffic studies, scientific analysis and engineering applications. Traffic Engineering includes the planning and geometric design on one hand and regulation and control on the other. It, therefore, deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

- To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one; and further, the application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.
- To understand the concept of various features of the highway geometrics and infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.
- To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.

- To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.
- To study the various components of the Transportation Planning process, their importance and various approaches/ methods/ models to be resorted to for each of these components.
- To understand the concept of economic evaluation of any of the transportation projects, its significance, various aspects associated with the evaluation; and various methods of economic evaluation.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Traffic Engineering**		**08**
	1.1	**Traffic Characteristics/ Characteristics of the Users of the Transportation System** Introduction to the Road User and the Vehicle; Road Users' (Human) Characteristics affecting their behavior; Vehicular Characteristics; Power Performance of Vehicles.	
	1.2	**Traffic Studies/ Surveys** Introduction to Spot Speed (space and time mean speed); Speed and Delay Studies (different types of delays, overall/ journey speed, running speed, journey time, running time); Traffic Volume Studies; Vehicle Occupancy Studies; Parking Studies; Accident Studies. Significance/ Objectives/ Necessity/ Application of the afore-mentioned studies; Methods of conducting these studies along with pros and cons (merits and drawbacks) of each of methods; Analysis Methodologies; Different methods of the Interpretation / Presentations of the Results.	
	1.3	**Application of Statistical Methods in the Traffic Engineering** Different Statistical Methods; Basic Concepts of the Terminologies pertaining to statistical methods; Poisson's, Binomial and Normal Distribution, Sampling theory and Significance Testing, Regression (Linear and Multiple) and Correlation	

2.		**Highway Geometrics and Parking System**	07
	2.1	Different Terms involved in Highway Geometrics; Types of Intersections (At grade and grade separated) and its further bifurcations/ classification along with merits and drawbacks; Conflict points and Conflict Area at Intersections; Flaring of Intersections; Principles behind designing the intersections. Channelization: Significance, Different types of islands within the layout of the road network and intersection or junctions. Speed Change Lanes; Rotary intersection: Merits and Demerits; Necessity; Different Types; Design Principle; Design of the Rotary.	
	2.2	Traffic and parking problems; different types of parking facilities (on street and off street along with further bifurcations therein); Truck Terminals; Long distance Bus Terminals.	
3.		**Highway Capacity and Introduction to Theory of Traffic Flow**	04
		Capacity; Difference between Capacity and Volume; Passenger Car Unit (PCU); Concept of Level of Service; Different Types of Capacities and Factors affecting the Capacity. Speed- flow-Density Relationships; Introduction to the Lighthill and Whitham's Theory; Car Following Theory and Queuing Theory	
4.		**Highway Safety/ Traffic System Management/ Lighting**	07
	4.1	Factors responsible for the accident; Preventive Measures; Traffic Management Measures and its implications on traffic flow and accident prevention Brief Introduction to the Highway Lighting: Importance; Principle of Visibility at Night; Factors influencing Night Visibility; Design Factors; Important Definitions; Law of Illumination; Discernment by Artificial Lighting; Mounting Height; Spacing; Lantern Arrangements; Types of Lamps; Lighting of Some Important Highway Structures; Design of Highway Lighting Systems.	
	4.2	**Traffic Control Devices (Signs, Signals and Marking)** Significance; Advantages and Drawbacks; Principles of TCDs; Different Types of Traffic Signs; Different Types of Traffic Signals; Terms	

	involved in Signals; Co-ordinated Control of Signals and Types of Co-ordinated Signal System; Various Approaches of Designing the Signals (determination of optimal cycle time and signal setting for an intersection with fixed time signals); Area Traffic Control and Delay at Signalized Intersections.	
5.	**Transportation Planning**	07
	Introduction to the process of urban transport planning. Trip Generation: Introduction; Factors affecting Traffic Generation and Attraction Rates; Multiple Regression Analysis, Category Analysis Trip Distribution: Importance; Different Methods of Trip Distribution, Uniform and Average Factor Method, Fratar Method, Furness Method, Gravity model, Opportunities Model. Traffic Assignment: Purpose; General Principles; Assignment Techniques (All or Nothing Assignment, Multiple Route Assignment, Capacity restraint assignment, Diversion Curves). Modal Split: General Considerations; Factors affecting Modal Split; Modal Split in the Transportation Planning Process Land Use Transport Models: Introduction; Selection of Land Use Transport Models; Lowry Derivative Models; Garin Lowery Model	
6.	**Transport Economics**	06
	Economic Evaluation of Transportation Projects; Necessity; Cost and Benefits of Transportation Projects, Basic Principles of Economic Evaluation, Interest Rate; Costs (Vehicle Operating; Time; Accident); Benefits (Direct and Indirect); Different Methods of Economic Evaluation (Benefit- Cost Ratio Method, First Year Rate of Return Method; Net present Value Method; Internal rate of Return Method); Comparison of the Various Methods of Evaluation vis-a-vis.	
	Total	**39**

Contribution to Outcomes

After successful completion of the course the students shall be able to

- Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
- Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
- Explain the concepts of PCU and LoS, their implication in determination of the capacity using Speed-Flow-Density relationships.
- Discuss the aspects associated with highway safety and different TSM measures.
- Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
- Plan the various features of highway geometrics and transportation infrastructure constituents to ensure safe, rapid, economical and efficient of the traffic.

Theory Examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. All the questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
3. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics and to give justice to all the contents of the entire syllabus.
4. The **first** question will be **compulsory**. The students will have to attempt any **three** questions out of remaining **five** questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work prepared by the student and appropriately certified by the course instructor/ teacher concerned.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems/questions on each sub-modules and contents thereof further. Apart from this, the students shall conduct at least three traffic surveys and shall prepare a detailed report of the analysis of these surveys. This report shall also form a part of the term work.

Distribution of the Term Work Marks:

The marks of term work shall be judiciously awarded for various components depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report of the Traffic Surveys: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, the following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Traffic Engineering and Transportation Planning: Kadiyali L. R., Khanna Publishers, Delhi.
2. Principles of Traffic Engineering: Pignataro, G. J., McGraw-Hill
3. Traffic System Analysis for Engineering and Planners: Wohl and Martin, Mc-Graw Hill
4. Highway Engineering: Khanna, S.K.; Justo, C.E.G. and Veeraraghavan, A.; Nemchand and Bros., Roorkee (10th Revised Edition)
5. Principles of Transportation Engineering: ParthaChakroborty and Animesh Das, Prentice Hall (India).
6. Highway Engineering and Traffic Engineering: Saxena, Subhash C.; C.B.S. Publishers
7. Transportation Engineering (Vol.-I): Venkatramaiah, C.; University Press, Hyderabad
8. Principles, Practice and Design of Highway Engineering: Sharma, S.K.; S Chand and Co. Pvt. Ltd., Delhi
9. Highway Engineering: Sriniwaskumar, R.; University Press, Hyderabad
10. Traffic Flow Theory and Control: Drew, D. R., Mc-GrawHill, New York

11. Transportation Engineering and Planning: Papacostas, C. S., Prevedouros, P. D., PHI Learning Pvt. Ltd.
12. Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt. Ltd.
13. Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.; McGraw-Hill.
14. Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, New York.
15. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
16. Relevant IRC Codes amended time to time.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6063	Department Level Optional Course-II: Ground Improvement Techniques	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	**20**	**20**	**80**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

A geotechnical engineer often needs to design new structures or repair the structures on or in problematic soils in engineering practices. The types of soil at construction sites are not always totally favorable for supporting civil engineering structure such as buildings, bridges, highways, tunnels, retaining walls, dams, offshore structures and many more. Soil needs to be treated using ground improvement techniques to enhance the soil strength. Similarly, specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. For both cases, the knowledge of Ground Improvement is required as ground improvement is an important to for a Geotechnical Engineer. This course will deal with different ground improvement techniques along with principles, design issues and construction procedures.

Objectives

- To enable students to identify problematic soils and their associated issues.
- To make the student understand for different ground improvement methods adopted for improving the properties of in-situ and remoulded soils.
- To make the student learn the concepts, purpose, methods and effects of soil stabilization.
- To make the student learn the concepts, purpose and effects of grouting.
- To provide the concepts of the reinforced earth and soil nailing to the students in conventional retaining walls.
- To enable the students to know ground anchors that can be used to improve the engineering performance of soils both in static and seismic condition

Detailed Syllabus

Module	Sub Modules/Contents	Periods
1.	**Introduction** Need for Ground Improvement, Different types of problematic soils, classification of ground improvement techniques, Emerging trends in ground Improvement techniques, economic considerations and suitability.	04
2.	**Compaction and Consolidation** Methods of compaction, Shallow compaction, Deep compaction techniques: Vibro-floatation, Blasting, Dynamic consolidation, pre-compression; accelerated consolidation by sand drains, free strain and equal strain cases, design of sand drain layout.	07
3.	**Stabilization of Soil** Methods of stabilization, mechanical stabilization: lime, cement, lime, fly-ash, bitumen, chemicals and polymer stabilization, stabilization by electro-osmosis.	05
4.	**Grouting** Grouting technology, Grout materials, physical and chemical properties, strength, Rheological aspects of coarse and fine grouts, penetrability and performance aspect of coarse and fine grouts, Various application of grouting.	06
5	**Stone Columns** Application, layout feature, procedures of installation, vibro float and rammed stone column, unit cell concept, load transfer mechanism, settlement in stone column, methods of improving the effectiveness of stone column, Design for stone column layout.	08
6.	**Reinforced Earth and Anchors** Necessity of reinforced earth, theory of reinforced earth, materials and method, application, design of reinforced earth, characteristics of reinforced earth masses; introduction to soil nailing and ground anchors; Capacity of shallow horizontal and vertical strip anchors by using Mononobe-Okabe method.	09
	Total	**39**

Contribution to Outcomes

After successful completion of the course students will be able to:

- Identify problematic soils and their associated issues.
- Study the various ground improvement techniques and propose suitable remedial techniques and design.
- Select appropriate soil improvement technique based on the soil type and application.
- Design grouting for various engineering applications in the field.
- Design stone column layout
- Design the geotechnical structures with the pseudo-static method under seismic condition

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on assignments. The term work shall cover the entire syllabus in such a way that the students would attempt conceptual theory part from each module. Further, groups of students (having maximum four students) shall be formed who shall analyse and design any **three** with different data from the following:

1. Design of sand layout in soft compressible clay deposit for required (accelerated) rate of consolidation.
2. Analysis of Horizontal or Vertical strip anchor by using Mononobe-Okabe Method to find the seismic capacity.
3. Design of a reinforced earth retaining wall.
4. Analysis and design of skirted stone columns.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Report on Analysis and Design: 10 Marks
- Attendance: 5 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to:

- 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Ground Improvement Techniques: P.P. Raj, Prentice Hall of India, (2005).
2. Engineering Principles of Ground Modification: M.R. Housmann, McGraw Hill, (1990).
3. Foundation Engineering Manual: N. V. Nayak, (2015).
4. IS15284 (Part 1): Design and Construction for Ground Improvement–Guidelines: (Stone Column), Bureau of Indian Standards, New Delhi, (2003).
5. Ground Improvement Techniques: Nihar Ranjan Patro, Vikas Publishing House (P) Limited, (2012).
6. Geotechnical Earthquake Engineering: S. L. Kramer, Pearson, (2013).
7. Earth Anchors: B. M. Das, Elsevier, (2012).

Reference books:

1. Constructional and Geotechnical Methods in Foundation Engineering: R.M. Koerner, McGraw Hill, (1985).
2. Design and Construction of Stone Column: FHWA Report No. Rd 83/026, (1983)

3. Principles of Foundation Engineering: B. M. Das, 7th edition, Cengage Learning, (2013).
4. Designing with Geosynthetics: R.M.Koerner,4th Edition,Prentice Hall, Jersey, (1999)

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6064	Department Level Optional Course-II: Advanced Structural Analysis	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	-	25	150

Rationale

There are various types of the civil engineering structures which are subjected to various types of loading and their combination. Most of the structures are indeterminate. There are various advances in methods to analysed these structures. The methods of analysis which are given in the syllabus are based on computer software.

Objectives

- To analyze the statically indeterminate portal frame.
- To study the methods and evaluating rotation and displacement parameters in complete frame using various methods.
- To analyze the symmetrical frame with symmetrical and anti-symmetrical loading.
- To understand the concept of analyze of non-prismatic frame and beam.
- To understand the concept of Influence lines for statically indeterminate beams.
- To understand in depth the stiffness matrix method of analysis, which is the basis of all compute-based software methods used in practice; finite element method, concepts thereof, different elements to be used along with various shape functions and solution methodology.

Detailed Syllabus

Module	Sub-Modules / Contents		Periods
1.	**Introduction to Stiffness Method in Matrix form**		10
	1.1	Basic concepts of stiffness coefficients, member stiffness matrix for beam, member stiffness matrix for plane truss, member stiffness matrix for rigid jointed plane frame, member stiffness matrix for plane grid and of space frame.	
	1.2	Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	
	1.3	Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members	
	1.4	Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	
2.	**Conventional Form of Stiffness Method, Modified Moment Distribution Method**		07
	2.1	Symmetrical structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames involving side sways.	
3.	**Flexibility Method in Matrix form**		04
	3.1	Review of concepts of flexibility coefficients, Flexibility member matrix for beam, member flexibility matrix for plane truss, member flexibility matrix for rigid jointed plane frame, member flexibility matrix for plane grid and of space frame.	
	3.2	Selection of primary structure, concepts of flexibility matrix, compatibility equation, solution for redundant forces, computational of internal forces, and joint displacement. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports.	

4.	**Conventional Form of Flexibility Method**		07
	4.1	Elastic Centre Method and its application to rectangular box, and rigid jointed portal frames.	
	4.2	Column Analogy Method and its application to analysis of non-prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non-prismatic beam members.	
5.	**Influence Line Diagrams for Indeterminate Structures**		05
	Muller Breslau's Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams.		
6.	**Introduction to Finite Element Method**		06
	6.1	Brief History of the Development; Advantages & Disadvantages of Finite Element Method.	
	6.2	Different elements (1-D, 2-D, 3-D, CST Elements); Shape Functions & Interpolation Polynomials for two nodded bar and beam elements; Stiffness Matrix for the basic Bar & Beam Element, Solution Methodology.	
		Total	**39**

Contribution to Outcomes

The students will be able to

- Understand the Stiffness Matrix method and will be able to analyze various types of structures by this method understand the conventional methods of analysis.
- Understand the methodology involved in commercially available computer software for analysis which are based on stiffness matrix method.
- Obtain the response of the indeterminate beams under the action of moving loads.
- Evaluate the displacement/ deflection in frames under the action of loads.
- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG program courses, in which they will be dealing with the indeterminate structures.
- Understand the concepts of the finite element method toward solving the problem, different elements and shape functions (displacement functions) to extend the application to the short problems.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short question having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.
At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 marks
- Attendance: 5 marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks.

Recommended Books:

1. Basic Structural Analysis: Reddy C. S. Tata McGraw hill.
2. Analysis of Framed Structures: Gere and Weaver, East-West Press
3. Analytical Methods in Structural Analysis: S. A. Raz, New Age Int Publishers
4. Modern Method in structural Analysis: Dr. B. N. Thadani and Dr. J. P. Desai, Weinall Book Corporation.
5. Sructural Analysis: L. S. Negi & R. S. Jangid, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: Pandit and Gupta, Tata McGraw hill.
7. Analysis of Structures: V.N.Vazirani and M.M.Ratwani Khanna Publishers.
8. Finite Element Analysis: S.S. Bhavikatti, New Age International Publication

Reference Books:

1. Matrix Method in structural Analysis: Livesley R. K. Pergamon Press, London.
2. Elementary Structural Analysis: Wilber, M MethodGraw Hill, New York.
3. Plastic Method of Structural Analysis: B. G. Neal, Chapman and Hall, London.
4. Intermediate Structural Analysis: Wang C. K., Tata McGraw hill
5. Matrix Method of Structural Analysis: Dr. A. S. Meghre, S. K. Deshmukh, Charotar Publishing House.
6. Finite Element Analysis: S. Rajasekaran, S. CHAND & COMPANY PVT. LTD
7. Finite Element Method with application in Engineering Y.M.Desai, T. I. Eldho and A.H, Shah PEARSON
8. Finite Element Method: Daryl L. Logan, THOMSON
9. Matrix Structural Analysis: William McGuire, Richard H. Gallagher, Ronaid D. Ziemian, Wiley India Pvt. Ltd.

Semester VI

Subject Code	Subject Name	Credits
CEC607	**Software Applications in Civil Engineering**	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	2	-	-	1	-	1

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	**25**		25	**50**

Rationale

With the advancements in software and technology, a significant revolution in Civil Engineering field has taken place. Software reduces all the extensive work, specifically through the introduction of programs and applications. Lately, software development has effectively contributed in various Civil Engineering disciplines. It provides engineers with the ability to perform variety of complex calculations, modelling, drafting, design practices and analytical processes with utmost ease. Further these software packages have wide capabilities and help engineers to analyze, design, plan and monitor projects, which earlier was a cumbersome job. Civil Engineering students need to learn all skill sets and demonstrate the practical applications to Engineering problems. Hence this course covers the study of various types of software packages and their application in Civil Engineering fields.

Objectives

Students are introduced to:

- All kinds of software packages available in various fields of civil engineering.
- Proficiency in applications of these software packages.
- Practical use of software results and their validation by relating them with analytical results by conventional methods.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**General**		02
	1.1	Importance and need of software for modeling, analysis and design in Civil Engineering field, Advantages and limitations of software, causes for errors, validation of software results. Failures due to errors in modeling, data entry and interpretation of software results.	
2.	**Software application in various disciplines of Civil Engineering:** Learning and practice of any one software from at least any 4 domain from 14 domain (2.1 to 2.14)		24
	2.1	**Drafting and drawing**: AutoCAD, Civil 3D, Auto plotter, Design and detailing of same using AutoCAD Beams (simply supported, continuous etc), Slabs (one way, two way), Columns, Portal frame, Truss	
	2.2	**building information modelling**: Revit and archicad, tekla , Navisworks, Trimble, AECOsim Building designer , Sketchup	
	2.3	**Numerical Analysis and Mathematical operations:** MATLAB Scilab	
	2.4	**Structural Analysis and Design:** STAAD Pro, ETABS, SAP 2000, SAFE, MIDAS.	
	2.5	**Finite Element Analysis**: ANSYS, ABAQUS, NISA	
	2.6	**Project Management:** Primavera, MS Project	
	2.7	**Geotechnical Engineering: Geo** studio, PLAXIS	
	2.8	**Quantity Surveying:** QS red, CCS Candy	
	2.9	**Environmental Engineering:** Storm CAD, EPANET, Sewer CAD	
	2.10	**Remote Sensing and Geographical Information System:** QGIS, GRAM++, Arc GIS	
	2.11	**Transportation Engineering:** MX Road, HDM, Road estimator	
	2.12	**Hydraulics and Water Resources Engineering**: Water Gems, Water CAD, Flow Master, Culvert Master, Nero solution, Discipulus, HEC-RAS, Arc SWAT, Hydrology: HEC, HMS	
	2.13	Different Open source software used for specific problems	

	2.14	**MS Excel:** Conduct concrete mix design for M40 grade concrete. or any exercise of Civil Engineering domain.	
		Total	**26**

Note: Course Owner is free to add and teach any latest additional software which is relevant to Civil Engineering Field and not listed in above curriculum.

Contribution to Outcome

After completion of the course, the students will be able to:

- Use the software in various disciplines of Civil Engineering
- Apply the software in to provide solutions to field problems.
- Validate the software results using judgment about range of answers.
- Identify theappropriate software application based on the field of Civil Engineering
- Apply equivalentopen source software based on thecase ofCivil Engineering specific problems.
- Integrate different softwares and their results for specific problems of Civil Engineering.

Term Work

A group of 3-4 students will prepare and give detailed power point presentation on any one software. Presentation should cover salient features, capability of software and should contain some applications from field.

The term work shall comprise of:

- At least hands-on working on one Software from any fourdomain listed above and preparing report of the same.
- Presentation Report on any one software.
- Open Source Software report (optional)

Distribution of the Term Work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the design report/ assignments and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work:

- Software Report: 16 marks
- Presentation: 4 marks
- Attendance: 5 marks

Further, while giving weight age of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended reading:

1. Software manuals.
2. Refereed Journal papers on Software applications.
3. NPTEL course like " MATLAB programming for numerical computation by Dr.NiketKaisare from IIT Madras and so on for other softwares.

R16 DE

Revised Syllabus as per
A.A.U. received Gmail dt.17.1.2020

University of Mumbai

No. UG/44 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/249 of 2010 dated 12th August, 2010 relating to the revised syllabus of Fourth Year (Sem.VII & VIII) of the B. E. Degree Course in branch of Civil Engineering.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 11th April, 2019 have been accepted by the Academic Council at its meeting held on 15th April, 2019 **vide** item No. 4.51 and that in accordance therewith, the revised syllabus as per the (CBCGS) for the B.E. Civil Engineering (Sem. VII & VIII) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
9th July, 2019

(Dr. Ajay Deshmukh)
REGISTRAR

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.51/15/04/2019

****

No. UG/44 -A of 2018-19 MUMBAI-400 032 9th July, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

AC 15/04/2019
ITEM NO: 4.51

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Civil Engineering

Second Year with Effect from A.Y. 2017-18

Third Year with Effect from A.Y. 2018-19

Final Year with Effect from A.Y. 2019-20

As per Choice Based Credit and Grading System

with effect from the A.Y. 2016–17

Dean, Faculty of Science and Technology

Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development. Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, semester-based credit and grading system is also introduced to ensure quality of engineering education. Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scales to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017- 18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Dean(I/c) Faculty of Science and Technology,

Member - Academic Council,

University of Mumbai, Mumbai

Chairman

Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education in the process of curriculum development. As the Chairman, Board of Studies in Civil Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The Program Educational Objectives finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome-based education.

I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. K. Ukarande

Chairman, Board of Studies in Civil Engineering,

University of Mumbai

University of Mumbai
Scheme of Instructions and Examination
Second Year Engineering (Civil Engineering)
(With effect from 2017- 2018)
(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
CE-C302	Surveying- I	20	20	20	80	3	25	25**	150
CE-C303	Strength of Materials	20	20	20	80	3	25	25	150
CE-C304	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai
Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (In Hrs.)				
		Test 1	Test 2	Avg						
CE-C501	Structural Analysis-II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai
Scheme of Instructions and Examination
Third Year Engineering (Civil Engineering)
(With effect from 2018- 2019)
(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course ‘Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course ‘Business and Communication Ethics (CE-C 507)’ will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying	CE-DLO6061: Advanced Construction Equipment
CE-DLO5062: Advanced Concrete Technology	CE-DLO6062: Traffic Engineering and Management
CE-DLO5063: Building Services and Repairs	CE-DLO6063: Ground Improvement Techniques
CE-DLO5064: Advanced Structural Mechanics	CE-DLO6064: Advanced Structural Analysis

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	--	2	4		2	6
CE-C703	Water Resource Engineering -II	3	--	2	3	--	2	5
CE-DLO704X	Department Level Optional Course-III	3	--	2	3	--	2	5
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**8**	**6**	**17**	**4**	**6**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 705), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai
Scheme of Instructions and Examination
Fourth Year Engineering (Civil Engineering)
(With effect from 2019-2020)
(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	2	--	4	1	-	5
CE-C802	Construction Management	4	2	--	4	1	-	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	--	3	--	--	3
CE-P804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**18**	**-**	**15**	**9**	**-**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	--	--	--	100
CE-P804	Project – Part II	--	--	--			50	--	50[#]	100
Total		**80**	**80**	**80**	**320**		**125**		**125**	**650**

[#] The oral examination for the Project- Part II (CE-P 804) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.

(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.

(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Applied Hydrology and Flood Control

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester-VII

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 701	**Quantity Survey, Estimation & Valuation**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Any structure, i.e., building, bridge, dam etc. consists of various building materials. Due to rise in the cost of materials, the structure has to be designed so that it is safe, serviceable and economical. Without proper design and estimation, it may lead to the increase in cost of construction and it further affects the economical aspect of the structure. A prior knowledge of various building materials is required for the construction and it controls the cost of the structure, save wastage of labour-hours and eventually helps in giving the correct amount required and quantity of various materials required. It also helps in scheduling of men, materials and machine to be used in the project at stages. The scope of the subject includes estimating, costing, analysis of rates, specification, valuation, tender and contracts etc.

Objectives

- To read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.
- To study the various methods of detailed and approximate estimates.
- To emphasize the importance of relevant IS: 1200- 1964 codes and relevant Indian Standard specifications, taking out quantities from the given requirements of the work, and drafting specifications.
- To conduct a material and labour survey to understand the current market rates for the various materials required for construction and the different categories of labour required.
- To perform the rate analysis for various items: standard and non-standard and the use of DSR in this process.
- To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.

Detailed Syllabus

Module	Sub-Modules/ Contents		Hrs
I.	**Introduction**		04
	1.1	Importance of Course	
	1.2	Measurement systems for various items of civil engineering structures.	
	1.3	Units of measurement of various items of works	
	1.4	I.S1200	
II.	**Specifications & Rate Analysis**		09
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of various items of work etc	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labour output ,District Schedule of Rates(DSR) Rate analysis of important items of construction works.	
III.	**Estimates**		14
	3.1	**Approximate Estimate** Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, Technical sanction, Contingencies, Work charged establishments etc.	
	3.2	**Detailed Estimate** Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Methods of taking out quantities such as long wall & short wall method, Centre line method etc Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structural elements as per code IS2502.Preparation of detailed estimate of R.C.C framed structures	
IV.	**Estimation of Earthwork for Roads & Canals**		06
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula, Spot level method etc. & numericals based on methods. Mass haul diagram & its necessity, Terms like lead & lift etc.	
V.	**Tenders & Contracts**		09
	5.1	**Tenders** Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & Opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	**Contracts** Definition, basic forms such as Valid, void & voidable contract. General types of contract with their suitability, conditions of contract	
	5.3	**Dispute resolution methods** Causes of disputes & disputes resolution methods such as litigation, mediation & arbitration	

VI.	**Valuation**		10
	6.1	Difference between cost, price & value. Types of value, Valuation & its purposes. Various terms such as depreciation, sinking fund, capitalized value, years purchase etc. Methods for calculating depreciation of building	
	6.2	Methods of valuation such as Rental method, land & building method, Belting method etc.	
	6.3	Freehold Properties, Leasehold Properties, Easement rights	
	6.4	Numericals based on valuation	

Contribution to Outcomes

On completion of the course, the learners will be able to:

- **Apply** the measurement systems to various civil engineering items of work.
- **Draft** the specifications for various items of work & determine unit rates of items of works
- **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures by referring drawings.
- **Assess** the quantities of earthwork **&construct** mass haul diagrams.
- **Draft** tender notice **&demonstrate** the significance of the tender as well as contract process.
- **Determine** the present fair value of any constructed building at stated time.

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** based on computation of quantities of various items of work by referring drawings.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the modules shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work shall consist of the following:

- At least **eight** assignments based on entire syllabus

- Detailed estimate of any **Three** of the following with the required material survey for the same.

- Single Storied building (RCC)
    - Load bearing structure
- Road work
    - Cross drainage work
- Valuation report in a standard format of the Government/ Private company/Firm.

The use of quantity survey software and the use of worksheets/databases while solving some of the afore-mentioned assignments is desirable.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weight age of marks shall be given for different components of the term work.

Assignments : 20 Marks **Attendance : 05 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.,* Kolkata.

2) Building and Engineering Contracts: *Patil, B. S.,* University Press, Hyderabad.

3) Estimating and costing: *Datta, B. N.,* UBS Publications

4) Relevant Indian Standard Specifications, BIS Publications

5) World Bank approved contract documents

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 702	**Theory of Reinforced Concrete Structures**	**06**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	-	02	04	-	02	06

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	04 Hrs.	25	-	25	150

Rationale

Working stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e. steel and the concrete. The limit state method (LSM) is based on the statistical probability which provides the rational solution to the design problem. The philosophy lies behind LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The subject involves the application of working stress and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

- To develop the clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using (WSM) working stress method and (LSM) limit state method.
- To study the various clauses of IS: 456-2000 and its significance in the RCC design.
- To apply the concepts of LSM in the analysis and design of beams, slabs and columns.
- To study the concept of Serviceability and durability for deflection and crack width calculation in RCC structures.
- To study the concept of reinforced concrete footing design subjected to axial load and moment.
- To develop the concept of design using ready charts and curves for column subjected to axial load and moments.

Detailed Syllabus

Module	Contents	Hrs
I.	**Working Stress Method** Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS-456-2000; stress- strain curve of concrete and steel, characteristics of concrete steel reinforcement. Concept of balanced, under reinforced and over reinforced sections. Analysis design of singly reinforced and doubly reinforced rectangular beams for flexure, shear by WSM, Analysis and design of Cracked and un-cracked RCC column sections by WSM	**12**
II.	**Limit State Method** Introduction to limit state method of design as per IS-456-2000; concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	**03**
III.	**Limit State of Collapse – Flexure, Shear, Bond and Torsion** Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing. Deflection and crack width calculation for RCC members.	**15**
IV.	**Design of Slabs using LSM:** Design of one way, one way continuous slab and two way slabs with all end conditions as per IS-456-2000.	**06**
V.	**Limit State of Collapse – Compression:** Limit state of collapse compression for short and slender column. Members subjected to combined axial and uni-axial as well as biaxial bending. Development of interactive curves and their use in column design.	**08**
VI.	**Design of Foundations:** Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing. Design of Raft foundations (No numerical to be asked on raft foundations in the exam)	**08**

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

- Understand the pros and cons of the WSM and LSM.
- Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
- Carry out analysis and design of various elements of the reinforced concrete structures such as beam, slab, column, footings using the concept of Limit state method.
- Understand and the use of readymade design curves from Special publications of Bureau of Indian standards.

Theory Examination:-

- **Use of IS:456-2000 shall be allowed in the examination.**
- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each modules/ sub-modules contents thereof. At least one numerical on raft foundation shall be included in assignments.

Distribution of Term-work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Mark

Recommended Books:-

1. Design of Reinforced Concrete Structures: *Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Jain A. K*, Nemchand and Bros., Roorkee
3. Limit State Design – Reinforced Concrete: *Shah and Karve*, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: *Arthur, P. D. and Ramakrishnan, V.*, Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: *Sinha& Roy*, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve*, Structure Publications, Pune.
8. Reinforced Concrete Design: *Wang, C. K., Salmon, C. G., and Pincheira, J. A*, John Wiley (2007), 7th Edition.

9. Reinforced Concrete Fundamentals: *Ferguson, P. M., Breen, J. E., and Jirsa, J. O.*, John Wiley & Sons (1988) 5th Edition.
10. RCC Design (WSM and LSM): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
11. Limit State Design of Reinforced Concrete (as per IS: 456-2000): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
12. Design of RCC structural Elements (RCC Vol-I): *Bhavikatti, S. S.*, New Age International Publications.
13. Reinforced Concrete: *Syal and Goel*; Wheeler Publishers.
14. Relevant IS Codes: BIS Publications, New Delhi.
15. Reinforced Concrete Design: *Pillai,S.U.*and*Menon,Devdas*, Tata Mc-Graw Hill Publishing House, New Delhi.
16. Reinforced Concrete Designby S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
17. Theory of Reinforced concrete structures by N. Subramanian , Oxford University Press.

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 703	**Water Resources Engineering II**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	-	02	03	-	02	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

This subject provides necessary knowledge about design of gravity dams, earthen dams, energy dissipaters, canal headwork's, and canal structures. This subject is also useful with respect to facts, concepts, principles and procedures related to canal design, canal lining, cross drainage works and water logging. Further students will be able to plan and execute the construction of these structures.

Objectives

- To understand different types of dams and its suitability to a particular region.
- To study design consideration of earthen dams
- To study various types of Spillways
- To understand the importance of silt theories for design of irrigation channels
- To study the classification of canals and design of canal system.

Detailed Syllabus

Module	Topics	Hrs
I	**Gravity dams** Definition, typical cross section, forces acting on gravity dam, modes of failure and structural stability analysis, profile of dam- elementary and practical profile, low and high gravity dam, design consideration and fixing of section of dam, methods of design, construction of galleries in dams, types of joints, temperature control in concrete dams, foundation treatment, Arch dams, types of arch dams	08
II	**Earth and rock fill dams:** Types of earth dams, method of construction, causes and failures of earth dams, design criteria, selecting suitable preliminary section, seepage line for different conditions and its location, seepage control through embankment and through foundations, Swedish circle method with pore pressure, details of	06

	construction and maintenance, types of rock fill dams, stability analysis, advantages	
III	**Spillways and flood control works:**	**06**
	Introduction, location of spillway, design consideration of main spillway, controlled and uncontrolled spillway, types of spillways, design principles of ogee spillway. Chute spillway. Siphon spillway and shaft spillway, energy dissipation below overflow and other types of spillways, design of bucket type energy dissipater and stilling basin, flood mitigation reservoirs. Crest gates, types, advantages, design of radial gate, outlet works through dams, intake structures.	
IV	**Irrigation Channels (Silt Theories)**	**07**
	Kennedy's theory, Kennedy's methods of channel designs silt supporting capacity according to Kennedy's theory. Drawbacks in Kenned' % theory Lacey's regime theory, Lacey's theory applied to channel design. Comparison of Kennedys and Lace 'S theory defects in Lacey's theory. Introduction to Sediment transport in channels.	
V	**Canal Head works and Distribution System**	**06**
	Canals: Classification, canal alignment, canal losses, estimation of discharge, cross sections of irrigation canals, maintenance of irrigation canal, canal lining, economics of canal lining, water logging, effect of water logging, remedial measures.	
VI	**Canal structures**	**06**
	Canal falls, types of canal falls, canal escapes, types, canal head regulators, cross regulators, canal outlets and its types cross drainage works and types of cross drainage works.	

Course Outcomes

On completion of this course the student will be able to:

- Design the section of gravity dams, earth and rockfill dams, arch dams and buttress dams.
- Design spillways and energy dissipaters.
- Apply silt theories to design irrigation canals.
- Explain various types of canals and its maintenance.
- Explain different cross drainage works of a canal system.

Theory examination:

1. The question paper will comprise of six questions; each carrying 20 marks.

2. The first question will be compulsory and will have short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. The students will have to attempt any three questions out of remaining five questions.

5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof further. It is advisable to arrange dam visit.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

- 75%- 80% : 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Recommended Books:

1. Irrigation and Water Power Engineering: *B.C. Punmia, PandeB.B.Lal, A.K Jain.* Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,*Ane Books Pvt. Ltd.ISBN,9789383656899.
3. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.
6. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand
7. Engineering for Dams, Vol. I to III:*Crager, Justin and Hinds*, John Wiley
8. Design of Small Dams: USBR.
9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross.
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7041	**Department Level Elective: Pre-stressed Concrete**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	-	2	3	-	2	5

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IAE-I	IAE-II	Avg						
20	20	20	80	3Hr	25	-	25	150

Rationale

The course is aimed to make the student to be aware of highly mechanized technology in civil engineering construction and to develop the basic understanding of pre-stressed concrete which is used in a wide range of building and civil structures. A Pre-stressed Concrete section improves performance/efficiency, reduces structural thicknesses, and material savings compared with simple reinforced concrete sections. Typical applications of pre-stressed concrete include high rise buildings, residential slabs and bridge structures etc.

Objectives

- To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of pre-stressed section over R. C. C. as a civil engineer.
- To make the candidate to understand the analysis of Pre-stressed Concrete sections and losses in pre-stress.
- To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

Detailed Syllabus		
Module	**Sub module/Contents**	**Hrs**
I	**Introduction to pre-stressed concrete and analysis of pre-stressed concrete section :** Basic concept and general principles, materials used and their properties, methods, techniques and systems of pre-stressing	04
II	**Analysis of Pre-stressed Concrete Section:** Loading stages, stress method, load balancing method and internal resisting couple method of analysis, cable profiles, pressure line, kern points, choice and efficiency of sections	10
III	**Losses in pre-stress:** Loss of stresses due to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction	06
IV	**Analysis of Pre-stressed Concrete Members in Limit State of Serviceability deflection:** Short time and long time deflection of uncracked members, permissible limits	05

V	**Analysis and Design of Pre-stressed Concrete Members for Limit State of Collapse Shear** Calculation of principle tension, permissible principle tension, Analysis and Design of members in shear (sections uncracked in flexure)	05
VI	**Analysis and Design of Pre-stressed Concrete Members for Limit State of Collapse Flexure and Serviceability Cracking** General philosophy of design, Analysis and design of members in flexure, permissible stresses in concrete and steel at different stages, suitability of section, safe cable zone	09

Contribution to outcome

On successful completion of the course, the students shall be able:

- To understand the basic concept, application and behaviour of pre-stressing over that of the RC structure.
- To have knowledge of modern engineering tools necessary for pre-tensioning and post-tensioning technology.
- To evaluate various losses occurring in pre-stressed concrete structure
- To analyze the various pre-stressed components of the structure and design the same for flexure as well as shear using relevant IS Code.
- To analyze pre-stressed concrete members for limit state of serviceability for cracking and deflection

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus, site visit and the term work.

Site Visit/ Field Visit:

The students shall visit the site where the construction of structure using pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

Term Work:

The term work shall consist of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems/ questions on each modules/ sub-modules and contents thereof further. The report of the site visit/ field visit shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled report of the site visit /field visit and the minimum passing marks to be obtained by the student.

The following weightage of marks shall be given for different components of the term work.

Assignments: 15 Marks
Report of the Site Visit/Field Visit: 05 Marks
Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to:

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Prestressed Concrete: *N. Krishna Raju*, McGraw Hill, New York.
2. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: *Sinha, N.C.*and*S.K. Roy*, S.C. Chand and Company.
4. Prestressed Concrete Structures: *Dayaratnam, P.*, Oxford andIBH
5. Design of Prestressed Concrete Structures: *T.Y.Lin*and*N.H. Burns*, John Willey, New York.
6. Design of Prestressed Concrete: *Nilson Arthur*, McGraw Hill Book Company.
7. Prestressed Concrete Vol—I: *IY.Guyon*, Contractors Record, London.
8. Prestressed Concrete: *S. Ramamurtham*, DhanpatRaiandSon's
9. Relevant latest IS codes (IS:1343-2012)

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7042	**Department Level Elective: Solid Waste Management**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	-	2	3	-	2	5

Evaluation Scheme

Theory					Teamwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Average**						
20	20	20	80	3Hr	25	-	25	150

Rationale

This course will be of interest to those wishing to understand the principles and techniques of solid waste management, including the legislative, environmental, economic and social drivers. Students will be introduced to the selection and design of appropriate methods of storage, collection, transfer, treatment and disposal in both industrialized and developing countries. The course also provides the opportunity to visit recycling facilities and disposal sites to better understand links between theory and practice.

Objectives

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.
- To provide knowledge of different types of sources, sampling and characteristics of solid waste.
- To impart knowledge and skills in the collection, storage, transport and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipments.
- To fully appreciate the current practices available and implement the systems available in solid waste management.
- To be aware of the significance of recycling, reduce, reuse of solid wastes and also to impart students with the skill of design and operation of disposal system based on latest technology.
- To provide students prerequisite knowledge necessary for higher studies and research in the field of Solid waste management.

Module	Sub Modules/Contents	Hrs
I	**Introducing Municipal Solid Waste Management** Overview: problems and issues of solid waste management - Need for solid waste management-Functional elements such as waste generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.	03
II	**Generation and characteristics of waste** Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes	03
III	**Waste collection, storage and transport** Collection and storage of municipal solid waste; Methods of collection - House to House collection -collection routes; on site storage methods-materials used for containers -Recycling and Reuse of waste -Need for transfer and transport; transfer station-selection of location, operation and maintenance; transportation Methods-manual, Mechanical methods with or without compaction, economy in transportation of waste optimization of transportation routes.	10
IV	**Waste processing techniques** Processing techniques-biological and chemical conversion technologies – composting and its methods, Vermi-composting, mechanical composting, In vessel composting, incineration, pyrolysis, gasification.	04
V	**Disposal of Solid Waste** Segregation, Volume reduction at source, recovery and recycle; dumping of solid waste-sanitary waste- sanitary landfills-site selection-design and operation of sanitary landfill - leachate and landfill gas management-landfill closure and environmental monitoring-landfill remediation; Municipal solid waste in Indian conditions, legal aspects of solid waste disposal, Plastic waste disposal.	10
VI	**Types of Solid Waste** **Industrial** Waste products during manufacturing and packing, operation of pollution control facilities, generation, and minimization at source, recycling, disposal. **Hazardous waste** Definition, sources, hazardous characteristics, management, treatment and disposal **Electronic waste** Waste characteristics, generation, collection, transport and disposal **Biomedical waste** Definition, sources, classification, collection, segregation- Color coding, treatment and disposal.	09

Contribution to outcomes

On completion of this course, the students will be able to understand the various methods of disposal of solid waste. They will have better understanding of the nature and characteristics of solid waste and regulatory requirements regarding solid waste management and further they will have an ability to plan waste minimization. Besides, they will be prepared to contribute practical solutions to environmental problems in our society.

After the completion of the course the student should be able to

- Explain generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.
- Understand the characteristics of different types of solid waste and the factors affecting variation.
- Identify the methods of collection, storage and transportation of solid waste.
- Suggest suitable technical solutions for processing of wastes.
- Ability to plan waste minimization and disposal of municipal solid waste.
- Ensure the safe handling and treatment of Hazardous, Electronic and Biomedical waste.

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.
-

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments, Tutorials including the site visit report.

Mini Project- Student should perform activities related to solid waste management at institute level forming groups 4 to 5 students, Report of the activity should be part of term work

Site Visit: The students will visit landfilling /composting site in the nearby vicinity and prepare detailed report thereof. This report will form a part of the term work.

Term Work:-

The Term Work shall comprise essentially of the following assignments covering the entire syllabus. The report of the site visit/ field visit and mini-project shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

The following weightage of marks shall be given for different components of the term work.

a. Report (on any industrial/hazardous/municipal solid waste/site visit): 05 Marks
b. Seminar/Mini Project : 05Marks
c. Attendance : 05 Marks
d. Assignments and Tutorials :10 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications.
4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, Rakesh Johri, The Energy and Resources Institute.
6. Biomedical Waste Management in India: Jugal Kishore and G. K. Ingle, Century Publications.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7043	**Department Level Elective: Pavement Subgrade and Materials**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	-	2	3	-	2	5

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Average**						
20	20	20	80	3Hr	25	-	25	150

Rationale

Highway and airways mode of transportation contributes to the economical, industrial, social and cultural development of any country. For the design and construction of highway and airfield, it is imperative to know the properties of the materials such as soil, aggregates and bitumen used in the construction of pavements. The various tests are required to be conducted to evaluate the properties of these materials for the scientific design of the pavements and economic utilization of the different materials. The course also deals with the soil survey, stresses in soil and various ways and means of improving the soil and implementing techniques of improvement. The course also deals with the various surface and sub-surface drainage.

Objectives

- To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards.
- To study the significance of the soil subgrade along with its functions.
- To study the soil classification for highway engineering purpose as per different classification system.
- To understand the concept of stresses in soil.
- To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
- Learn bituminous mix and cement concrete mix designs
- Learn basic principles of superpave technology of bituminous mixes

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I.	**Soil: Soil-Classification methods, Tests:**CBR test, effect of lateral confinement on CBR and E value of Subgrade soil, Consistency, Engineering Properties and Modulus of sub-grade reaction ofsoil, estimation of modulus of subgrade reaction, Static and cyclic plate load test, correction for plate size, correction for worst moisture content. Soil classification as per HRB.	08
II.	**Stresses in Soil:** Theories of elastic and plastic behavior of soils, Cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for testing , Relation for Moisture content and Dry Density of Stabilized mixes, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes.	06
III.	**Aggregate:** Classification, requirements, Blending of aggregates, Importance of aggregate shape factor in mix design. Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials),	04
IV.	**Bitumen, Tar and Bituminous Mix Design**; requirements, criteria for selection of different binders, Temperature susceptibility, Bituminous emulsion and Cutbacks, fillers, extenders Polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance.	08
V.	**Bituminous Mix Design:** selection of different grade of bitumen, skid qualities, types of bituminous surfaces, bituminous mix design, Marshall Stability test, design aspect of paving concrete.Experimental characteristics of road aggregate.	06
VI.	**Introduction to Super pave Technology:** Methods of selection of suitable ingredient for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test. Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method.	07

Contribution to Outcomes

On the successful completion of the course, the students shall be able to:

- Understand the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material.
- Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
- Understand the characterization of different paving materials along with the tests to be conducted on these materials.
- Know the various ground improvement methods.
- Understand subgrade soil strength in terms of standard engineering parameters.
- Application of basic principles of mix design of cement concrete and bituminous mixes

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

Term Work:

The term-work shall comprise of the neatly written report comprising of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ two questions on each modules/ sub-modules and contents thereof further.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work which will comprise of the report on assignments. The final certification and acceptance of term-work warrants the satisfactory and the appropriate completion of the termwork; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

Assignments : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.* , John Wiley and Sons, Inc., New York.
2. Concrete Roads: *HMSO*, Road Research Laboratory, London.
3. Highway Engineering: *Khanna, S.K., Justo, C,E.G. and Veeraragavan, A.*,Nem Chand and Brothers, Roorkee (10th Revised Edition, 2014)
4. Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B.Lal*, Khanna Publishers, New Delhi.
5. Highway Engineering, *Sharma, S.K.*, S. Chand Technical Publishers, New Delhi (3rd Revised Edition, 2013).
6. Principles of Transportation and Highway Engineering: *Rao, G.V.* , Tata Mc-Graw Hill Publications, New Delhi

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7044	**Department Level Elective: Structural Dynamics**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	-	2	3	-	2	5

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Duration of ESE**	**TW/TU**	**PR**	**OR**	
IAE-I	**IAE-II**	**Avg.**						
20	20	20	80	3Hr	25	-	25	150

Course Objective

- To expose the students to understand the basic theory of structural dynamics, structural behaviour under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.
- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete Two DOF systems,
- To study the modal analysis of Two DOF systems and analysis of systems with distributed mass for continuous system.

Details Syllabus

Module	Contents	Hrs
I	**Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.** Static vs. Dynamic loads. Different types of dynamics loads	4
II	**Introduction to single Degree of freedom (SDOF) Systems.** Undamped vibration of SDOF system natural frequency and period of vibration Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor. Response of structure subjected to General dynamic load, Duhamel's Integral Numerical Evaluation of Dynamics Response of SDOF system. Equivalent stiffness of spring in series and parallel	8

III	**Introduction to vibration isolation.** Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	4
IV	**Lumped mass multi-degree of freedom (Two DOF) system, coupled and uncoupled system** Direct determination of frequencies of vibration and mod shape. Orthogonality principle. Vibration of Two DOF systems with initial conditions Approximate method of determination of natural frequencies of vibration and mode shapes – Energy methods	9
V	**Earthquake analysis – Introduction.** Seismicity of a region, causes of earthquake Intensity of earthquake, Richter Scale, Measurement of Earthquake ground motion, Seismogram, construction of seismograph Application of modal analysis concept to seismic disturbance, Introduction to Response spectrum method.	8
VI	**I.S code provisions for seismic analysis of buildings.** Approximate method of earthquake analysis– Seismic co-efficient method and its limitation Introduction to time history analysis.(6)	6

Contributions to Outcomes

The students will be able to

- Understand the difference between static and dynamic loads and analysis.
- Evaluate the response of SDOF and Two DOF systems to different types of dynamic loads including ground motions.
- Understand the basics of random vibrations and the application of this concept
- Analyze Linear SDOF systems.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-module content thereof further. There shall be theory questions as well.

Distribution of Term-work Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks 91% onwards: 05 Marks

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination

Oral examination will be based on entire syllabus and the afore-mentioned term work.

Recommended Books:-

1. Craig R.R.: 'Structural Dynamics-An Introduction to Computer Methods',*John Wiley and Sons.*

2. Anil K. Chopra: 'Dynamics of Structure's', *Prentice Hall India Pvt. Ltd.*

3. Cloguhand Penzein: 'Dynamics of Structures'*TataMc-Graw Hill Pvt. Ltd.*

4. John M. Biggs: 'Structural Dynamics',*TataMc-Graw Hill.*

5. Mario Paz: 'Structural Dynamics Theory and Computation', *CBS Publisher.*

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7045	**Department Level Elective: Applications of Geographic Information Systems & Remote Sensing**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	--	02	03	--	02	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg.**						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

Geographic Information Systems & Remote Sensing Applications provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret date to understand relationships, patterns and trends. In this subject, the students get acquainted with the detailed study of GIS & Remote sensing. Data models of spatial and non-spatial information are also explained. An overview on digitizing, editing and structuring of map data is also provided for error detection, correction and appropriate topology creation. Digital Elevation Models (DEM) and their needs are also incorporated along with the applications of Remote Sensing and GIS. Solution can be provided for Various Civil Engineering problems using Integration GIS-GPS & Remote Sensing Techniques.

Objectives

- To study principles of physics of Electromagnetic radiation as applied to remote sensing.
- To learn the GIS data & its processing using Softwares
- To get acquainted with GPS Satellite & their segments
- To understand the GIS & RS Applications in various fields of Civil Engineering

Module	**Content**	**Hrs**
I	**Remote sensing (RS):** Introduction, physics of remote sensing- electromagnetic radiations and their characteristics, thermal emissions, multi-concept in remote sensing, remote sensing satellites and their data products, sensors and orbital characteristics, spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation- visual interpretation, concept of fcc, digital image processing- digital image and its characteristics, satellite data formats, image rectification and restoration, image enhancement- contrast manipulation, spatial feature manipulation, multi-image manipulation.	8

II	**Geographical Information System (GIS):** History, Introduction, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS Commercially available GIS hardware and Software Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, pre-processing of data rectification and registration , interpolation techniques, introduction to GIS softwares (Arc GIS, QGIS, Gram++, etc.)	8
III	**Global Positioning System (G.P.S) :** G.P.S. Segments: Spaces Segment, Control Segment, User Segment Features of G.P.S. Satellites, Principle of Operation Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S., Kinematics of G.P.S. G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co-ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights Applications of G.P.S	5
IV	**Application of G.I.S.& R.S. in Water Resources & Environmental Studies:** Site selection of Hydraulic Structures, Surface water delineation, surface keys for subsurface water, Steps in water investigations of the area, Water management	6
V	**Application of G.I.S.& R.S. in Infrastructure Management;** Role of GIS in Town Planning, Urban Transport Planning, Underground Infrastructure Management	6
VI	**Application of G.I.S.& R.S in Disaster Management :** RS and GIS applications for disaster vulnerable zones, fire hazards, flood and storm water inundations, earthquake impact assessment, post Tsunami/ cyclone damage assessment.	5

Contribution to Outcomes

After completion of course, student will be able to:

- Explain the principles of physics of Electromagnetic radiation as applied to remote sensing.
- Describe Spatial and non-spatial database of geographic information system
- Demonstrate the GPS Satellites & their Segments.
- Apply the GIS & RS techniques in Urban Planning, Water Resources & Environmental Management.
- Integrate the GIS-GPS & RS techniques for Infrastructure Management
- Illustrate applications of GIS& RS in Disaster Management

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work will comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and /or questions on each sub-modules and contents thereof further

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weight age of marks shall be given for different components of the term work.

Assignments : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Introduction to Geographic Information Systems: Kang-Tsung Chang,TataMcGrawHill.
2. Text book on Remote Sensing –C.S. Agrawal and P.K.Garg,Wheeler Publishing, New-Delhi.
3. G.I.S- Anji Reddy, publishers- MGH.
4. GIS, Spatial Analysis, and Modeling: Maguire, D., M.Batty,andM.Goodchild.2005. ESRIPress.
5. Remote sensing in Civil Engineering – T. J. M. Kennie and M. C. Mathews, Surry University press, London
6. Principles of Remote Sensing- P.N.Patel and Surendra Singh, Scientific Publishers, Jodhapur.
7. Remote Sensing and Image Interpretation: Lillesandand Kiefere:, JohnWiley,1987.
8. Global Positioning System: Signals, Measurements, and Performance, Pratap Misraand Per Enge (2nd Ed.), 2006.
9. Introduction to Geomatics –QGIS user guide – Mr.C.V. Nishinkanth, Mrs.Annu Nishinkanth, Dr S S Vasudevan, Dr P Ramkumar

10. Fundamental of Remote sensing: George Joseph, Universities Press Publications.
11. Remote Sensing and GIS, Basudeb Bhatta, Publisher: Oxford University Press, India, Latest Edition

Semester VII		
Subject Code	**Subject Name**	**Credits**
CEC-DLO7046	**Foundation Analysis and Design**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	-	02	03	-	02	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	25	-	25	150

Objectives

- To study the bearing capacity and settlement of shallow foundations and To understand the design concepts for shallow foundations including strip and raft foundations
- To study the estimation of vertical stresses in soil
- To study different types of well foundations
- To study the load carrying capacity of pile and design of under reamed piles
- To study Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils and to analyse braced cuts
- To learn different types of machine foundations and understand the design philosophy; and carry out the design thereof.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	**Estimation of stresses in soils:** Boussinesque and Westergaard's theories, Newmark Chart, Practical applications.	06
II	**Shallow Foundation**: Basic requirements of foundation, types and selection of foundation, design of shallow foundations by Terzaghi's and IS code method; total settlement analysis including elastic settlements; Structural design of strip and raft foundation.	07
III	**Pile Foundation**: Introduction, Necessity of piles, Types of pile foundation, load carrying capacity of single pile and pile in group, , group efficiency, group settlements, design of single pile and pile cap, design of under-reamed pile foundation	06
IV	**Floating Foundation and Well Foundation:** Floating Foundation- Introduction, Floatation, bottom elastic heave, Design of floating foundation on piles, Well Foundation- Introduction, forces acting on well foundation.	06
V	**Sheet piles and Braced cuts:** Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils: lateral earth pressure diagram,	08

	computation of embedment depth. Difference in open cut and retaining wall theories, apparent earth pressure diagram, Average apparent earth pressure diagram for cohesion-less and cohesive soils. Estimation of strut loads in braced cuts placed in cohesion-less and cohesive soils.	
VI	**Machine Foundations:** Introduction, Dynamic soil properties, types of machine vibrations, basic principal of machine foundation.	06

Contribution to outcomes

- On successful completion of the course, the learner shall have an: 1. Ability to identify, formulate and solve geotechnical engineering problem.
- Ability to design a suitable foundation system from economic and safe aspects
- Ability to design machine foundations
- Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.
- Ability to understand design of sheet pile
- Ability to analyze vertical stresses developed in soil and used in practical problems

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments, Tutorials.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

The following weightage of marks shall be given for different components of the term work.

- Attendance : 05 Marks
- Assignments and Tutorials :20 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Bowels J.E.: 'Analytical and Computer Methods in Foundation', *McGraw Hill Book Co. New York, 1974*
2. Das, B. M.: 'Geotechnical Engineering Handbook', *J. Ross Publishing, 2010*
3. Verghese, P. C.: 'Foundation Engineering'. *PHI Learning Private Limited, Delhi, 2012*
4. Verghese, P. C.: 'Design of Reinforced Concrete Foundations', *PHI Learning Private Limited, Delhi, 2011*
5. N. Subramanian: 'Reinforced Concrete Structures', *Oxford University Press, 2013*
6. Alam Singh: 'Soil Mechanics and Foundation Engineering', Vol. I- II. *Standard Book House, Delhi*
7. Swami Saran: 'Analysis and Design of Substructures', *Oxford and IBH publishing company, Delhi 1998*

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC-7011	**Institute Level Elective: Product Life cycle Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Module	Detailed Contents	Hrs
I	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
II	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
III	**Product Data Management (PDM):**	05

	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
IV	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
V	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
VI	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Contribution to Outcomes:

Students will be able t

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach". Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7012	**Institute Level Elective: Reliability Engineering**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Module	Detailed Contents	Hrs
I	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
II	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
III	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
IV	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
V	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics,	05

	Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
VI	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	**05**

Outcomes

Students will be able to…

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Assessment:
Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:
In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7013	**Institute Level Elective: Management Information System**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Module	Detailed Contents	Hrs
I	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
II	**Data and Knowledge Management**: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
III	**Ethical issues and Privacy**: Information Security. Threat to IS, and Security Controls	7
IV	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
V	**Computer Networks Wired and Wireless technology**, Pervasive computing, Cloud computing model.	6
VI	**Information System within Organization**: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. **Acquiring Information Systems and Applications**: Various System development life cycle models.	8

Contribution to Outcomes

Students will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

SemesterVII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7014	**Institute Level Elective: Design of Experiments**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Detailed Contents	Hrs
I	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
II	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
III	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
IV	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design	07

	4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
V	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
VI	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Contribution to Outcomes

Students will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rdedition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7015	**Institute Level Elective: Operation Research**	**03**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Module	Detailed Contents	Hrs
I	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
II	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

III	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**05**
IV	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	**05**
V	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**05**
VI	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	**05**

Outcomes:

Students will be able to

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7016	**Institute Level Elective: Cyber Security and Laws**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Module	Detailed Contents	Hrs
I	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
II	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
III	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
IV	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8

V	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
VI	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Outcomes

Students will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7017	**Institute Level Elective: Disaster Management and Mitigation Measures**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	**--**	**--**	**03**	**--**	**--**	**03**

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**--**	**--**	**--**	**100**

Objectives

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Module	Detailed Contents	Hrs
I	**Introduction** **1.1** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	**03**
II	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	**09**
III	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration:	**06**

	Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
IV	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	**06**
V	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	**09**
VI	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	**06**

Outcomes:

Students will be able to…

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Semester VII		
Course Code	**Course Name**	**Credits**
CE-C ILOC7018	**Institute Level Elective: Energy Audit and Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Module	Detailed Contents	Hrs
I	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
II	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
III	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
IV	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
V	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
VI	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Outcomes:

Students will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Semester-VIII

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 801	**Design and Drawing of Reinforced Concrete Structures**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Reinforced concrete construction are widely used for residential, commercial and industrial structures. IS code has specified the use of Limit State Method (LSM) design philosophy for design of structures. Pre-stressed Concrete structures are another class of structures used for bridge girders, long span slabs etc.Civil engineers must have knowledge of designing and detailing of RCC and PSC structures to make structures safe and serviceable during its life span.Also the knowledge about response of structures during an earthquake is prerequisite of design engineers. During previous semester students have studied design of basic elements by LSM. This course coves complete design of G+ 3 structures in addition to advanced topics of design of water tank and retaining wall. The course also contains PSC beam topics and introduces Earthquake Resistant Design of structures, drawing and detailing of structures.

Objectives

- To explain the LSM design procedure of G+ 3 structures by proper application of IS code clauses including loading calculation, analysis and design of individual elements.
- To acquaint the concepts in the design of staircase, water tank and retaining wall.
- To explain concept of Pre-stressed Concrete members.
- To introduce Earthquake Resistant Design method.
- To explain drawing and detailing of structures.
- To develop the concept of design using ready charts and curves for different elements of structure.

Detailed Syllabus		
Module	**Contents**	**Hrs**
I	**COMPREHENSIVE DESIGN OF BUILDING:** Complete design of residential/commercial/industrial G+ 3 structures. Load transfer mechanism, arrangement of beams, slabs, columns. Design of footing, beams, columns, staircase, lintels, chajja.	**12**
II	**DESIGN OF STAIRCASE:** Design of dog legged and open well staircase	**3**
III	**DESIGN OF RETAINING WALL:** Design of Cantilever and Counterfort retaining wall	**7**
IV	**DESIGN OF WATER TANK** Classification of Water Tank, Permissible Stresses, design of circular and rectangular water tanks resting on ground and underground. Codal provisions. Use of IS coefficient method and approximate method. Design of elevated water tank frame and shaft type of staging.	**11**
V	**EARTHQUAKE RESISTANT DESIGN OF STRUCTURES:** Earthquake and ground motion, response of structure, design forces calculation by seismic coefficient method. Ductile design and detailing as per IS:13920.	**12**
VI	**PRE-STRESSED CONCRETE:** Pre-stressed Concrete: Basic principles of pre-stressed concrete, materials used, systems of pre-stressing, losses in pre-stress, analysis of beam sections at transfer and service loads.	**7**

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

- Design independently RCC structure by applying IS code provisions.
- Design staircase, water tank and retaining wall.
- Explain principles of PSC and calculate losses.
- Draw and explain the structural detailing.
- Explain response of structure during an earthquake and calculate design forces.

Theory Examination:-

- Question paper will comprise of five questions. First question will carry 32 marks and remaining four will carry 16 marks each. The **first** question will be **compulsory.** From remaining four questions any **three** questions can be answered. Total **four** questions need be attempted.
- The **first** question will be based on design project from following. (any one out of given two is to be answered)
- Design of slab and continuous beam (max three span) or design of column from terrace to footing.
- Design of counter fort retaining wall
- Design of overhead water tank including design of staging
- The next four questions will be based on remaining modules of syllabus and the weightage of the marks shall be judiciously awarded in proportion to the importance of the module and number of hours allotted for the module. There can be an **internal** choice in various

sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

- All relevant IS codes will be allowed during examination.

Oral Examination:@

The oral examination accompanied by **sketching** will be based on entire syllabus and the term work and site visit report.

Term Work:

The term work shall consist of a neatly written Design Report including detailed drawings on the following topics:

- Design report of (G+3) building using relevant IS codes.
- Design report of counter fort retaining wall OR overhead water tank and staging.
- Report of one site visit to under construction building/PSC site.
- Assignments consisting of max five questions each on module III to VI.

Design report and at least four A-1 (Full imperial) size drawings sheets for above two projects shall be submitted as term work. All drawing work is to be done in pencil only. Design of building project will be done using design aids and anyone of available software.

Distribution of Term Work Marks: The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled design report; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Design report and drawing sheets : 15marks
- Assignments and site visit report: 05 marks
- Attendance : 05 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

Recommended Books:-

1. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Shah and Karve,* Structure Publications, Pune.
3. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand& bro.
4. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
5. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve*, Structure Publications, Pune.
6. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A,John Wiley.
7. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons.
8. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
9. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House,NewDelhi
10. Prestressed concrete, problems and solutions , Krishna Raju, CBS Publishers and distributors, New Delhi.
11. Prestressed concrete: N. Rajgopalan, Narosa Publishers.
12. Earthquake resistant design of structures: S. K. Duggal, Oxford University Press.
13. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
14. Relevant IS Codes: BIS Publications, New Delhi

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 802	**Construction Management**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This course is intended to teach students the management skills to be applied during all the stages of Civil Engineering Project. The professional construction engineering practice will be rendered meaningless if service is not offered with a scientific approach and managerial practices. This course deals with the techniques to be applied for scheduling projects, optimizing time-cost and other resources in construction, monitoring & ensuring quality and safety aspects in projects.

Objectives

- To understand the basic functions and construction management.
- To apply scheduling techniques such as CPM & PERT.
- To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.
- To understand allocating the resources and project monitoring
- To know about safety and quality aspect of construction works..

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	**Introduction to Construction Management** 1.1 Concept of Management, Principles of management, contribution by eminent personalities towards growth of management thoughts. 1.2 Significance of construction, management, objectives& functions of construction management 1.3 Resources required for construction.	**06**

II	**Construction Projects:** 2.1 Role of Construction industry in economic development of country 2.2 Unique features of construction industry. 2.3 Construction projects- Classification, Characteristics, Project life cycle etc. 2.4 Roles and responsibilities of various agencies associated with a Construction project. 2.5 Pre-requisites of commencing construction work such as sanctions, Approvals to be sought, and feasibility studies. 2.6 Site layout, organizing & mobilizing the site	**06**
III	**Construction project planning & Scheduling:** 3.1 Stages of planning in the view of owner/Department as well as contractor. 3.2 W.B.S, Bar Charts. 3.3 Network-Terminology, Network Rules, Fulkerson's rule, skip numbering, Precedence network etc. 3.4 C.P.M- Activity & event with their types, activity times, event times, Critical path, forward pass, backward pass, float & its types. 3.5 P.E.R.T- Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project etc.	**12**
IV	**Resources Management & Allocation :** 4.1 Material Management- Importance, objectives, functions of material management, Inventory control, A-B-C analysis, E.O.Q etc. 4.2 Human Resource Management- Manpower planning, recruitment, Selection training, performance evaluation of worker etc. 4.3 Resources Allocation Methods- Resource levelling resource smoothening.	**10**
V	**Project Monitoring & Cost Control :** 5.1 Supervision, record keeping, Periodic progress reports etc. 5.2 Updating- Purpose of frequency of updating method of updating a network etc. 5.3 Time cost optimization in construction projects compression & decompression of network etc. 5.4 Common causes of time over run & cost overrun & Corrective measures.	**08**
VI	**Construction Safety, Quality Control & Labour Legislation :** 6.1 Common causes of accidents on construction sites, costs of accident, precautionary measures to avoid accidents, 6.2 Occupational health hazards in construction industry. 6.3 Safety & Health Campaign. 6.4 O.S.H.A 6.5 Concept of Quality, quality control check list in quality control etc. 6.6 Role of inspection in quality control, 6.7 Quality manual, Quality assurance statistical quality control 6.8 ISO14000 6.9 Need for legislation & Importance of labour laws. 6.10 Acts applicable to Indian construction labours such as Payment of wages act, Minimum wages act, Workmen's compensation act, Factories act etc.	**10**

Contribution to Outcomes

On completion of the course, the learners will be able to:-

- Understand & apply the knowledge of management functions like planning, scheduling, executing & controlling the construction projects.
- Prepare feasible project schedule by using various scheduling techniques.
- Gain knowledge of managing various resources &recommend best method of allocating the resources to the project.
- develop optimum relationship between time & cost for construction project
- Implement quality & safety measures on construction sites during execution of civil engineering projects.
- Understand the importance of labour legislation

Term Work: At least 10 assignments covering the entire syllabus.

Distribution of Term Work Marks: The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 marks
- Attendance : 05 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

Theory Examination:

- The question paper will comprise of six questions, each carrying 20 marks.
- The first question will be compulsory & out of remaining questions students have to attempt any three questions.
- Total four questions need to be attempted.

Oral Examination: The oral examination shall be based on the entire syllabus & the Term-work prepared by the students including assignments..

Recommended books:

1) Construction Engineering and Management: S.Seetharaman.
2) Construction Planning & Management – Dr.U.K.Shrivastava.
3) Professional Construction Management: Barrie D.S. & Paulson B C, McGraw Hill
4) Construction Project Management: Chitkara K K Tata McGraw Hill
5) Handbook of Construction Management: P K Joy, Macmillan, India
6) Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley
7) Construction Hazard and Safety Handbook: King &Hudson, Butterworths

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8031	**Department Level Elective:** **Advanced Design of Steel Structures**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

There are various types of the Civil Engineering structures which are subjected to various types of loading and their combination. Most of the industrial structures for which the higher strength is a prime concern, are made up of steel .These special structure are design by working stress method and limit state method. The design approaches of different components given in the syllabus are based on limit state method and working state method.

Objectives

- To understand the analysis and design concept of round tubular structures
- To understand the design concept of different type of steel water tank
- To understand the design concept of lattice tower and steel chimney
- To understand the design concept of gantry girder
- To develop Civil Engineering graduates having clear understanding of concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.
- Use various relevant IS codes for designing such special steel structures

Detailed Syllabus		
Module	**Sub – Modules / Contents**	**Hrs**
I	**1.1 Introduction to Steel Structure** Introduction to types of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM), Limit state method and design of simple bolted connection.	03
	1.2 Moment Resistant Beam End Connections : Design of moment resistant bolted and welded beam end connections by limit state method	05
II	**2.1 Round Tubular Structural Members :** Properties of steel tubes, design of tension member and compression member, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports.	06
III	**3.1 Elevated Steel Tanks and Stacks :**	14

	Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation, design of rectangular steel tanks including design of staging, columns and foundation. .(consider the effect of wind and earthquake)	
IV	**4.1. Gantry Girder :** Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	**07**
V	**5.1 Lattice Tower :** Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower, design of lattice tower including welded or bolted connections for members by limit state method.(consider the effect of wind and earthquake)	**09**
VI	**6.1 Steel Chimney :** Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation. .(consider the effect of wind and earthquake)	**08**

Contribution to Outcomes

On completion of this course, the students will be able

1. To perform the analysis and design of special steel structures
2. The will be able to analysis and design the gantry girder by limit state method.
3. They will be able to analysis and design steel chimney, lattice tower, tubular truss and water tank
4. Students should able to independently design steel structures using relevant IS codes.

Theory Examination:-

1. Question paper will comprise of six question; each carrying 20 marks.
2. The first question will be compulsory and will have short question having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted

Oral Examination:
The oral examination shall be based upon the entire syllabus and the term work consisting of the assignments and projects.

Term Work:
The Term work shall consists of a design report and detailed drawings on three projects as indicated below:

1) Roofing system including details of supports using tubular section
2) Design of elevated circular tank with conical bottom or rectangular steel tank.
3) Design of lattice tower or steel chimney.

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets. Each student has to appear for at least two written test during term .The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work.

The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments and projects.

Recommended Books:

1 Design of Steel Structures : N Subramanian,Oxford- University Press
2 Design of Steel Structures: Punamia, A. K. Jain &Arun Kumar Jain .Laxmi Publication
3 Design of Steel Structures: Dayaratnam, Wheeler Publication, New Delhi.
4 Design of steel structures: Krishnamachar B.S, &AjithaSinha D.
5 Design of Steel Structures: Mac. Ginely T.
6 Design of Steel Structures: Kazimi S. M. & Jindal R. S., Prentice Hall of India.
7 Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.
8 Design of Steel Structures: Arya and Ajmani, New chand& Bros.
9 Relevant IS codes, BIS Publication, New Delhi
10 Steel structures, Controlling behavior through design: R. Englekirk, Wiley
11 LRFD Steel Design : William T. Segui, PWS Publishing
12 Design of Steel Structures: Edwin H. Gaylord, Charles N. Gaylord and James. Stallmeyer, McGraw-Hill

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8032	**Department Level Elective: Industrial Waste Treatment**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Industrial waste waters are generally much more polluted than the domestic or even commercial wastewaters. Such industrial wastewaters cannot always be treated easily by the normal methods of treating domestic wastewaters, and certain specially designed methods. In order to achieve this aim, it is generally always necessary, and advantageous to isolate and remove the troubling pollutants from the wastewaters, before subjecting them to usual treatment processes. Thus Wastewater treatment is closely related to the standards and/or expectations set for the effluent quality. Wastewater treatment processes are designed to achieve improvements in the quality of the wastewater.

Objectives

- To provide knowledge of different types and characteristics of industrial wastes. Also to make the students conversant with effluent and stream standards.
- To study the problems faced by many industrial plants with new effluent limits to be met with their existing treatment plant.
- To understand in-depth yet practical review of wastewater treatment technologies and how to optimize their operation.
- To develop rational approaches towards sustainable waste water management via sludge recovery and treatments.
- To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by various industrial activities prior to its release into the environment or its re-use.
- To study the sources of contaminants, legislative framework for their remediation as well as the technical aspects of the unit operations involved. To Utilize EIA documents for policy development, project planning or for legal or political action planning.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Hrs**
I	General:Liquid wastes from industries – their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, stream standards and effluent standards.	**04**
II	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	**04**
III	Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelp's equation and BOD equations, Deoxygenating and reaeration , Oxygen sag and numerical based on this.	**06**
IV	General treatment of industrial wastes:Neutralization, Equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges,unit operation– floatation, Vacuum filtration, Centrifugation, Filter press and membrane filters, Advanced treatment.	**12**
V	Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed , Volume and effects of raw and treated effluent on streams, Sewers, Characteristics of effluents and land Treatment methods, reuse-recovery 1) Sugar-sugarcane 2) Distilleries 3) Pulp & paper: Sulphate process 4) Textiles: Cotton 5) Dairy 6) Tanneries 7)Electroplating	**16**
VI	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit. Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation & Maintenance Problems and Economical aspects.	**10**

Contribution to outcomes

On completion of this course, the students will have an ability to understand the industrial waste sources, effects and its treatment. The students will understand the various methods of disposal of industrial waste. They will have an understanding of the nature and characteristic of industrial waste and regulatory requirements regarding industrial waste treatment and further, they will have an ability to plan industrial waste minimization.

Students should able to

- Understand the characteristics of industrial wastewater.
- Identify sampling method and analyze industrial waste.
- Design facilities for the processing and reclamation of industrial waste water.
- Explain on-site treatment methods and solve Analyze and design wastewater treatment systems. (floatation, vacuum filtration, centrifugation, filter press and membrane filters)
- Detailed on-site manufacturing processes and treatments of industrial waste water.
- Analyze proposed development project plans for possible environmental effects and to improve treated effluent quality to confirm standard prescribed by regulatory agencies.

Theory Examination:-

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work consisting of the Assignments and Tutorial including the site visit report.

Term Work:

Mini Project- Student should perform activities related to solid waste management at institute level forming groups 4 to 5 students, Report of the activity should be part

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report comprising design criteria and flow sheet of the proposed treatment scheme including laboratory analysis for any one industrial waste. Demonstration of available software for design of effluent treatment plant is to be considered.
The following weightage of marks shall be given for different components of the term work.

- Report (on any industry/site visit): 05 Marks
- Seminar/Mini Project : 05Marks
- Attendance : 05 Marks
- Assignments and Tutorials :10 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Waste Water Treatment: Rao & Datta, Oxford & IBH Publishing Co.
2. Environmental Pollution and control in chemical process industries: S.C.Bhatia, Khanna Publication.
3. Industrial Water Pollution Control: W W Eckenfelder Jr, Mc Graw Hill.
4. Industrial Water Pollution Management: E F Gurnham, John Wiley.
5. Biological Waste Treatment: Eckenfelder & Connor Pergamon Press.
6. Theories and Practices of Industrial Waste Treatment: Addisoon Wesley.
7. Pollution Control in Process Industries: S P Mahajan , Tata mcgraw Hill.
8. Industrial Waste: W Rudolfs ,(Ed), L E C Publishers Inc.
9. The Treatment of Industrial Wastes: E D BesselievreMcgraw Hill.

10. Industrial Waste Disposal: R D Ross , (Ed), Reinhld Bok Croporation.
11. Wastewater Engineering, Treatment and Reuse : Metcalf and Eddy,Tatamcgraw Hill
12. Industrial Wastewater Management Handbook, Hardam S. Azad.
13. Industrial Waste Treatment, Frank Woodwoard.
14. Environmental Impact Assessment :Larry W. Canter, Mcgraw Hill Book Company.
15. Environmental Impact Analysis Handbook :G.J. Rao and C.D. Weeten ,Mcgraw Hill
16. Environmental Management, Vijay Kulkarni and T. V. Ramchandra, Capital Publishing
17. Environmental Audit, MhaskarA.K.,Enviro Media Publications.

Semester VIII		
Subject Code	Subject Name	Credits
CE-C DLO8033	Department Level Elective: Pavement Design and Construction	5

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The pavements are classified according to mode of transportation (highway and airways) and structural behaviour (flexible and rigid). The design of any pavement warrants the proper analysis thereof. The course deals with the various methods of the analyses and design of pavements. The evaluation of the pavements on routine basis and subsequent maintenance is essential to avoid the distresses in pavements. The course also covers the various distresses likely to take place in the pavements and various methods of evaluating the existing pavements. The distressed pavement needs either strengthening or rehabilitation depending upon the distresses the pavement has undergone. For the proper working and maintenance of the pavement, the concept of pavement management system has emerged. The course also covers these aspects. It also gives major thrust on the low volume roads and construction of concrete roads.

Objectives

- To study the different types of pavements(highway and airfield) depending upon the mode of transportation, use and structural behaviour.
- To understand the concept of consideration of wheel loads, axle loads, wheel-axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
- To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations.
- To study the various methods of analysis and design of the pavements and its subsequent applications to the various types of pavements.
- To study the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
- To study the construction of the concrete roads and low volume roads.
- To study the quality control and quality assurance in the road construction and introduce pavement management system.

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I.	Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highways and airports, development of design method for highway and airport pavements.	12
	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL Stresses in Rigid pavement: load and temperature stresses, combined stresses.	
II.	Flexible Pavement Design Airport pavement: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. Highway Pavement: Empirical methods using no soil strength criteria, empirical method based no soil strength criteria: CBR method as specified by IRC-37 1970,1984,2001,2012,2018 Road note 29 methods, AASHTO method, Asphalt institute method. Fatigue and rutting as a failure criterion.	16
	Rigid Pavement Design: Airport pavements: PCA methods, corps of Engineer's method, FAA method. Joints and reinforcement requirement. Highway pavement: Current British procedure, IRC-58-2012,2015. method.	
III.	Evaluation and strengthening: flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman beam deflections, design of overlays(IRC-81-1997), skid resistance and measurement.	12
	Concrete road construction: Mix design, concrete strength, size of aggregates, gradation, and workability, preparation of base form work, placing of reinforcement, compaction, and finishing, curing, joints.	
IV.	Low Cost Roads (Rural Areas) (IRC-SP-20-2002) Classification of low cost roads, construction of low cost roads, stabilization of subgrade, base and its advantages, construction of granular base courses, macadam surface, macadam bases, low cost materials and methods used for highway construction, suitability of different types of roads under different situation. Soils.	05
V	Quality control (QC) and Quality assurance (QA) during construction of various pavements, importance, process control and end product control, statistical methods in quality control, control charts, frequency of testing etc. (IRC-SP-11-1997) (MORTH SECTION 900).	05
VI	Introduction to pavement management systems.	02

Course Outcome

On successful completion of the course, the students shall be able to:

- Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
- Understand the applications of the analysis in the design of pavements using different methods of pavement design.
- Know the different types of distresses occurring in the existing pavements and carry out the structural and functional evaluation of the pavements.
- Apply the knowledge of evaluation in pre-empting the failure and to arrive upon the methodology of the rehabilitation of pavements.
- Understand the various aspects of the construction of concrete roads and low volume roads.
- Understand the pavement management system and quality control and assurance criteria and subsequently, its application in the highway construction.

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:-

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality of the term work. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Principles and Practice of Highway Engineering: *L.R.Kadiyali*, Khanna publications.
2. Highway Engineering: *Khanna S.K. and Justo* C.E.G. Nem Chand (Revised 10th Edition, 2014)
3. Pavement design
4. Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3rd Revised Edition, 2013) 4.Pavement Analysis and Design: *Yang H. Huang*, Prentice Hall, New Jersey, 1993
5. Pavement Design: *Yoder* and*Witzech*, McGraw-Hill, 1982.
6. The Design and Performance of Road Pavements: *Croney, David et al*, McGraw Hill.

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8034	**Department Level Elective: Bridge Engineering and Design**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

In the age of increase in traffic load and rapid transportation, bridges are a very important part of a nation's transportation infrastructure associated with the economic growth. They allow for roads and railways to cross over otherwise impassable obstacles such as rivers, valleys or other roads etc. Bridges are being built mainly with reinforced concrete, pre-stressed concrete or steel depending on various factors such as environment& site conditions, nature of loads and span etc. The civil engineering profession is much concerned with proper planning, design and construction, as well as maintenance, repairs and rehabilitation of bridges which are of utmost importance. In this subject, students will be well acquainted with the types of bridges and their selection based on the specific needs. They will learn analysis and design of superstructure of Reinforced Concrete Culvert and Pre-stressed Concrete bridges for IRC loads along with basics of substructure (foundation, Pier, abutments) using relevant IRC. They will also understand the analysis and design of a lattice girder bridge in steel for railway loading using relevant bridge rules and IRS.

Objectives

- To bring the students to such a level that they being civil engineers will be able to take the appropriate decision in respect of choice of site, type of bridge, components of bridge, superstructure, sub structure, foundation, type of bearing and launching method of girder and construction methods.
- To make the candidate to understand the analysis and design of reinforced concrete culvert/Pre-stressed Concrete bridges using relevant IRCs.
- To make the candidate to understand the analysis and design of lattice girder steel bridge for railway loading using relevant IRS code.

Detailed Syllabus		
Module	**Sub module/Contents**	**Hrs**
I.	**Introduction:** Types of Bridges, Selection of suitable site and type of bridge, Components of a bridge, aesthetics, economic span	**06**
II.	**Design Loads and their Distribution:** **IRC loads:** IRC-Class AA tracked and wheeled, 70R tracked and wheeled, Class-A, Class-B, distribution of loads on RC culverts, Pre-stressed Concrete deck slab and girdered bridge, **IRS loads**: Railway loading and distribution on lattice girder bridge	**10**
III.	**Design of Superstructure:** Design of pre-stressed concrete deck slab bridge, I-girder bridge and box girder bridge for roadway, Design of RC Culvert, Design of balanced cantilever RC bridge for roadway, Design of steel lattice girder bridge for railway	**20**
IV.	**Substructure:** Different types of foundations, their choice and methods of construction, well foundation, pile foundation, piers and abutments, wing walls	**06**
V	**Bearing:** Various types of bearings and their suitability	**05**
VI	**Construction Methods:** Various methods of erection of bridge girders, cantilever method of construction of bridge	**05**

Contribution to outcome

On successful completion of the course, the student shall be able to:

- Select the suitable type of bridge according to the site condition.
- Understand IRC loads, distribution of these loads on deck slab and among longitudinal beams/girders of a bridge.
- Design of culvert, balanced cantilever reinforced concrete bridge, prestressed concrete deck slab bridge, I-girdered and box girdered bridge, lattice girder railway bridge.
- Understand different types of foundations, piers and abutments, their methods of construction.
- Understand various types of bearings and their suitability, erection of bridge superstructure.

Theory Examination: -

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to importance of sub-module and contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Site Visit/ Field Visit:

The students shall visit the site where the construction of bridge structure using pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

Oral Examination:

The oral Examination shall be based upon the entire syllabus, term work and site/field visit.

Term work:

The termwork shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus. There shall be minimum four problems for design of roadway bridges and one railway bridge.

Presentation on any emerging trend in bridges, its design, methods of erection and construction, types of foundations and bearings etc relevant to syllabus.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and the acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: **10 Marks**
- Presentation: **05 Marks**
- A Bridge site visit report **or** A project on Design of superstructure of a bridge using software: **05 Marks**
- Attendance: **05 Marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

References

A-Recommended Books:

1. Design of Bridges: *Raju N. K.*, Oxford and IBH fifth Edition.
2. Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill.
3. Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill.
4. Essentials of Bridge Engineering: *Victor D.J*, Oxford and IBH.
5. Design of Bridge Superstructures: *T.R. Jagdeesh*and*M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi.
6. Bridge Engineering Handbook: *Chen W. F. and Duan L.*, CRC Press, 2000.
7. Bridge Bearings and Expansion Joints: *David Lee*, E & FN Spon.

B-IRC Codes:

IRC: SP13- 2004, IRC: 5- 2015, IRC: 6- 2016, IRC: 18-2000, IRC: 21-2000, IRC: 24-2001, IRC: 27-2009, IRC: 45, IRC: 78-2014, IRC: 83 (i)-1999, IRC: 83 (ii)-1987, IRC: 83 (iii)-2002, IRC:112- 2011

C-IRS Codes:

IRS- 2003, Bridge rules (Railway board): Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges- 2008.

Indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic (steel bridge code) adopted- 2003

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8035	**Department Level Elective: Appraisal & Implementation of Infrastructure Projects**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This course is intended to make students aware of the appraisal criteria for any Civil engineering project. This course will make students understand the importance of feasibility studies and acquaint them with the process of preparing a project report, both of which play a significant role in deciding the viability of a project. The professional construction engineering practice will be rendered meaningless if student do not grasp the knowledge of financial analysis. This course shall be helpful to students in studying all the economic aspects of Infrastructure projects.

Objectives

- To know the procedure of feasibility studies for any infrastructure project.
- To learn the procedure of appraisals required for deciding the worthiness of any project.
- To learn the procedure of forecasting demand and know its importance.
- To know the components and importance of technical appraisal.
- To make students acquainted with important decision making tools like Break even analysis, SWOT analysis and other ways to carry out economic analysis of a project.
- To get acquainted with different methods of implementing a project.

Detailed Syllabus

Module	Sub-Modules/ Contents		Hrs
I.	**Construction Projects and Report Preparation**		06
	1.1	Classification of construction projects. Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis. Preparation of Project report.	
II.	**Project Appraisal**		08
	2.1	Importance and phases in a project development cycle for major infrastructure projects.	
	2.2	Importance of Appraisal, its need and steps involved in it.	
III.	**Market Appraisal**		10
	3.1	Importance and methods of carrying out demand analysis. Sources to gather project related information and ways to carry out market survey.	
	3.2	Methods to forecast demands. Uncertainities involved in demand forecasting.	
IV.	**Technical and Managerial Appraisal**		08
	4.1	Method to study the technical appraisal/viability of a project in terms of its location, type of land and intended use of building, technology requirements of the project, Size and complexity of tools and plants, raw materials to be used and their impact on the vicinity, energy requirements, water supply and disposal of effluents if any.	
	4.2	Study of managerial requirements of a project, Desirable organisational structure and hierarchy to manage as well as implement the project, Method of assessment of entrepreneurs.	
V.	**Financial analysis and Economic Appraisal**		10
	5.1	Various costs related to a project, Methods to determine the profitability of a project, Break even analysis.	
	5.2	Economic appraisal: Urgency, Payback period, Avg. Rate of return, Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VI.	**Project Financing and Implementation**		10
	6.1	Types and Sources of finance in local, National and International context. Issues related to project financing.	
	6.2	Agencies involved in the implementation of a project. Methods of implementation like Built, operate and Transfer and its other variants like B.O.O, B.O.O.T, B.L.T, etc.	

Contribution to Outcomes

On successful completion of the course, the learners will be able to:

- **Classify** the projects and **describe** the phases involved in project formulation.
- **Prepare** detailed project report on the basis of various feasibility studies and SWOT analysis.
- **Devise** a project's development cycle and get acquainted with the different appraisals **in** the process of deciding the worthiness of a project.
- **Exhibit** and **apply** the managerial skills and knowledge of financial aspects required during the implementation of projects.
- **Identify** various sources for project finance.
- **Know** the various agencies involved in project implementation as well as **select** the method of project implementation which is best suited for a particular project.

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral examination will be based on the entire syllabus and the term work.

Term Work:

The term work shall consist of the following:

- Minimum **Six assignments** covering the entire syllabus.
- **Report** on studying the SWOT Analysis of any one major infrastructure project.
- **Case study – Powerpoint presentation** covering the various appraisals of any one major infrastructure project.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and powerpoint presentation. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

Assignments:20 Marks.

Attendance: 05 Marks. Further, while giving weightage of marks on the attendance, guideline to be resorted to is: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Mark

Recommended Books:

1) Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra (Tata McGraw Hill).
2) Infrastructure Development & Financing in India - N. Mani (New Century Publications).
3) Infrastructure & economic development - Anu Kapil (Deep&Deep Publications).
4) Construction Management: Planning and finance - Cormican D.(Construction press, London).
5) Engineering Economics – Kumar (Wiley, India).
6) Real Estate, Finance and investment - Bruggeman.Fishr (McGraw Hill).
7) The cost management toolbox; A Managers guide to controlling costs and boosting profits. - Oliver, Lianabel (Tata McGraw Hill).

Semester VIII		
Subject Code	Subject Name	Credits
CE-DLO 8036	Department Level Elective: Soil Dynamics	05

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

In basic geotechnical engineering course generally various static loads are considered in the theories and analysis of soil. But practically many geotechnical applications require the knowledge of the behaviour and properties/response of soil as a material which is subjected to various types of dynamic or cyclic time-dependent loadings. Some of the structures which are subjected to dynamic loadings are machine foundations, shallow and deep foundations, retaining structures, slopes, sub grade soil below railway, pavement, runway etc. This course provides the fundamental theoretical and computational aspects of dynamics for some important geotechnical problems and structures.

Objectives

- To study fundamental concepts of vibrations, degrees of freedom and damping systems.
- To study phenomena like liquefaction and their effects.
- To study principals of machine foundation design and dynamic earth pressure theories on retaining wall.
- To learn test methods of evaluating dynamic properties of soil.
- To know the basic earth pressure on retaining walls

Detailed Syllabus		
Module	Sub- Modules/Contents	Hrs
I.	Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics. Vibration of elementary system, degree of freedom, analysis of system with one degree of freedom, spring-mass system, harmonic vibration, uniform circular motion natural frequency, free and forced vibrations with and without damping, type of damping	10
II.	Wave propagation in elastic rods, in an elastic infinite medium and in Semi-elastic half space, wave generated by surface footing.	05

III.	Liquefaction of soils, criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefaction potentials, Liquefaction of clay.	**10**
IV.	Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration. Practical design considerations and codal provisions.	**06**
V.	Vibration isolation and screening methods, improvement of distressed machine foundation.	**07**
VI.	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils. Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure, point of application of the resultant, simple examples.	**14**

Course Outcome

On successful completion of the course, the students are expected to:

- Acquire the knowledge of concepts, principles and applications of soil under dynamic loading.
- Develop an ability to design with reference to code provisions and solve the practical soil problems subjected to vibrations.
- Provide an impetus to new developments in related dynamic topics.
- Carry out field tests on soil to know the dynamic properties of soil.
- Calculate the dynamic earth pressure on retaining walls.

Theory Examination:-

- Question paper will comprise of **six** questions; each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** questions.

Total **four** questions need to be attempted.

Laboratory Test

It is recommended to conduct block foundation tests.

Oral Examination:-

The oral examination will be based on the entire syllabus.

Term Work:

Each student shall prepare a project report covering the selection of design parameters, design analysis including drawing on any aspect of soil dynamics included in the syllabus. The project report referred above along with the assignments will form a part of the term work. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub- modules and contents thereof, further. The report on the block vibration tests, if conducted, shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for various components of the term work depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments, proper compilation of the project report and that of experiments/ practical, if conducted;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20Marks
- Attendance : 05Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended books:

1. Soil Dynamics: *Shamsher Prakash,* McGraw-Hill book company
2. Principles of Soil Dynamics: *Braja, M. Das*, PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: *Barkan, D. D.*, McGraw- Hill Book company
4. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc.
5. E. E. Richart et al. "Vibrations of Soils and Foundations", Prentice Hall Inc.
6. Relevant IS codes

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8037	**Department Level Elective: Applied Hydrology & Flood Control**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	**02**	**--**	**04**	**01**	**--**	**05**

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**03 Hrs.**	**25**	**-**	**25**	**150**

Rationale

This subject deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It focuses on types and forms of precipitations. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows. It further describes the various techniques of estimating streamline flows. It also describes the importance of floods, flood routing and ground water hydrology.

Objectives

- To understand the various processes involved in the hydrological cycle.
- To measure rainfall, computation of average rainfall, various water losses etc.
- To know the various stream flow measurement and its importance.
- To study the hydrograph and unit hydrographs, applications of unit hydrograph concept.
- To study various flood control methods, estimate design flood, and flood routing
- To study the concepts of ground water movement, steady and unsteady flow towards fully penetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ Contents	Hrs
I	**Introduction:** Hydrological cycle, scope of hydrology, water budget equation, data sources. **Precipitation:** Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration -Frequency relationship, Probable Maximum Precipitation.	10
II	**Abstractions from Precipitation:** Evaporation and transpiration, evapo-transpiration, interception, epression storage, infiltration and infiltration indices, determination of water losses. **Stream Flow Measurement:** Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	10
III.	**Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	8
IV.	**Hydrograph Analysis:** Characteristics, base *flow* separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	8
V.	**Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor. Flood routing: Hydrologic and hydraulic routings.	8
VI.	**Ground Water Hydrology:** Yield , transmissibility, Darcy's law, DuPont's theory of unconfined flow, steady flow towards fully penetrating wells(confined and unconfined).Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	8

Contribution to Outcomes

On successful completion of the course, the students are expected to:

- Explain hydrologic cycle and various methods of Measurement of rainfall.
- Calculate optimum number of rain gauge stations for average rainfall and missing rainfall over catchment
- Describe various methods of measurement of stream flow and to calculate abstraction losses over the catchment
- Develop rainfall runoff relationship and calculating runoff over catchment
- Perform hydrologic and hydraulic routing
- Derive the equations for the discharge of well for confined and unconfined aquifer

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The **remaining five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term Work:

The term work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and / or questions on each sub-modules and contents thereof further.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

Assignments : 20 Marks
Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

- Engineering Hydrology: *K. Subramanya*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Irrigation Engineering and Hydraulic Structures: *S. K. Ukarande*, Ane‘s Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
- Hydrology: *H. M. Raghunath*, New Age International Publishers, New Delhi
- Irrigation and Water Power Engineering: Dr. *B.C. Punmia* and Dr. *Pande, B.B.Lal*, Laxmi Publications Pvt. Ltd. New Delhi.
- Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi
- Irrigation Water Resources and Water Power Engineering: Dr. *P.N. Modi*, Standard Book House. Delhi.
- Elementary Hydrology: *V. P. Singh*, Prentice Hall
- Engineering Hydrology: Principles and practice: *V. M. Ponce*, Prentice Hall

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C ILOC8021	**Institute Level Elective: Project Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Module	Detailed Contents	Hrs
I	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
II	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
III	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8

IV	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	**6**
V	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	**8**
VI	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	**6**

Outcomes

Students will be able to :

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 questions
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8022	**Institute Level Elective: Finance Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Module	Detailed Contents	Hrs
I	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
II	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
III	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	09

	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
IV	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10**
V	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**05**
VI	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	**03**

Outcomes

Students will be able to…

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8023	**Institute level Elective : Entrepreneurship Development and Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Module	Detailed Contents	Hrs
I	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
II	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
III	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	05

IV	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
V	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
VI	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Outcomes:

Students will be able to…

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question.
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad

8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8024	**Institute level Elective : Human Resource Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Module	Detailed Contents	Hrs
I	**Introduction to HR** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
II	**Organizational Behavior (OB)** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);	7

	Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	
III	**Organizational Structure &Design** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**6**
IV	**Human resource Planning** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	**5**
V	**Emerging Trends in HR** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	**6**
VI	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labour Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**10**

Contribution to Outcomes:

Students will be able to:

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.

- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Assessment:
Internal:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:
In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Semester VIII		
Course Code	Course Name	Credits
CE-C ILOC8025	Intitute level Elective : Professional Ethics and CSR	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry	08

	of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	

Contribution to outcomes
Students will be able to… • Understand rights and duties of business • Distinguish different aspects of corporate social responsibility • Demonstrate professional ethics • Understand legal aspects of corporate social responsibility

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

SemesterVIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8026	**Institute level Elective : Research Methodology**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	**Research Methodology** 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem. b. Formulation of Research Problem c. Review of Literature	08

	d. Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Outcomes

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8027	**Institute level Elective : IPR & Patenting**	**03**

Teaching Scheme

Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					**Term work / Practical / Oral**			**Total Marks**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Module	**Detailed Contents**	**Hr**
01	**Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	**05**
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	**07**
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	**05**
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while	**07**

	patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	**08**
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	**07**

Outcomes:

Students will be able to…

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian,2012,Intellectual Property Rights, 1st Edition,Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8028	**Institute Level Elective : Digital Business Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Module	Detailed content	Hrs
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	**09**
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	**06**
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	**06**

4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	**06**
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	**04**
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	**08**

Outcomes:

Students will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Semester VIII		
Course Code	**Course Name**	**Credits**
CE-C ILOC8028	**Institute level Elective : Environmental Management**	**03**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Avg**						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Module	Detailed Contents	Hrs
I	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
II	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
III	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
IV	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
V	Total Quality Environmental Management, ISO-14000, EMS certification.	05
VI	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Contribution to Outcomes

Students will be able to…

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

AC – 11.05.2017

Item No. 4.193

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To equip the Learner with broad education necessary to understand the impact of Computer Science and Engineering in a global and social context.
4. To encourage, motivate and prepare the Learner's for Lifelong- learning.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. Subhash K. Shinde
Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-III)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC301	Applied Mathematics -III	4+1@	-	-	5	-	-	5
CSC302	Digital Logic Design and Analysis	4	-	-	4	-	-	4
CSC303	Discrete Mathematics	3+1@	-	-	4	-	-	4
CSC304	Electronic Circuits and Communication Fundamentals	4	-	-	4	-	-	4
CSC305	Data Structures	4	-	-	4	-	-	4
CSL301	Digital System Lab	-	2	-	-	1	-	1
CSL302	Basic Electronics Lab	-	2	-	-	1	-	1
CSL303	Data structure Lab	-	2	-		1	-	1
CSL304	OOPM(Java) Lab	-	2+2*	-	-	2	-	2
	Total	**21**	**10**	-	**21**	**5**	-	**26**

@ 1 hour to be taken tutorial as class wise.

*2 hours shown as practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC301	Applied Mathematics -III	20	20	20	80	3	-	-	-	100
CSC302	Digital Logic Design and Analysis	20	20	20	80	3	-	-	-	100
CSC303	Discrete Structures	20	20	20	80	3	-	-	-	100
CSC304	Electronic Circuits and Communication Fundamentals	20	20	20	80	3	-	-	-	100
CSC305	Data Structures	20	20	20	80	3	--	-	-	100
CSL301	Digital System Lab	-	-	-	-	-	25	--	25	50
CSL302	Basic Electronics Lab	-	-	-	-	-	25	25	---	50
CSL303	Data structure Lab	-	-	-	-	-	25	-	25	50
CSL304	OOPM(Java) Lab	-	-	-	-	-	50	--	50	100
Total		100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-IV)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC401	Applied Mathematics- IV	4+1@	-	-	5	-	-	5
CSC402	Analysis of Algorithms	4	-	-	4	-	-	4
CSC403	Computer Organization and Architecture	4	-	-	4	-	-	4
CSC404	Computer Graphics	4	-	-	4	-	-	4
CSC405	Operating System	4	-	-	4	-	-	4
CSL401	Analysis of Algorithms Lab	-	2	-	-	1	-	1
CSL402	Computer Graphics Lab	-	2	-	-	1	-	1
CSL403	Processor Architecture Lab	-	2	-		1	-	1
CSL404	Operating System Lab	-	2	-	-	1	-	1
CSL405	Open Source Tech Lab	-	2+2*	-	-	2	-	2
	Total	**21**	**12**	-	**21**	**6**	-	**27**

@ 1 hour to be taken tutorial as class wise .

*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC401	Applied Mathematics- IV	20	20	20	80	3	-	-	-	100
CSC402	Analysis of Algorithms	20	20	20	80	3	-	-	-	100
CSC403	Computer Organization and Architecture	20	20	20	80	3	-	-	-	100
CSC404	Computer Graphics	20	20	20	80	3	-	-	-	100
CSC405	Operating System	20	20	20	80	3	--	-	-	100
CSL401	Analysis of Algorithms Lab	-	-	-	-	-	25	--	25	50
CSL402	Computer Graphics Lab	-	-	-	-	-	25	--	25	50
CSL403	Processor Architecture Lab	-	-	-	-	-	25	25	-	50
CSL404	Operating System Lab	-	-	-	-	-	25	-	25	50
CSL405	Open Source Tech Lab	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1		1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	**20**	**14**	-	**20**	**7**	-	**27**

@ 1 hour to be taken tutorial as class wise.
*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
Total		100	100	100	400	-	150	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract**	**Tut**	**Theory**	**TW/ Pract**	**Tut**	**Total**
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Complier Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
	Total	**20**	**12**	-	**20**	**6**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					**TW**	**Oral**	**Oral & Pract**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam Duration (in Hrs)**				
		Test 1	**Test 2**	**Avg.**						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Complier Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	150	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC701	Digital Signal & Image Processing	4	-	-	4	-	-	4
CSC702	Mobile Communication & Computing	4	-	-	4	-	-	4
CSC703	Artificial Intelligence & Soft Computing	4	-	-	4	-	-	4
CSDLO 701X	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course-I	3	-	-	3	-	-	3
CSL701	Digital Signal & Image Processing Lab	-	2	-	-	1	-	1
CSL702	Mobile App. Development. Tech. Lab	-	2	-	-	1	-	1
CSL703	Artificial Intelligence & Soft Computing Lab	-	2	-		1	-	1
CSL704	Computational Lab-I	-	2			1	-	1
CSP705	Major Project-I	-	6			3	-	3
	Total	**19**	**14**	-	**19**	**7**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC701	Digital Signal & Image Processing	20	20	20	80	3	-	--	-	100
CSC702	Mobile Communication & Computing	20	20	20	80	3	-	--	-	100
CSC703	Artificial Intelligence & Soft Computing	20	20	20	80	3	-	--	-	100
CSDLO 701X	Department Level Optional Course -III	20	20	20	80	3	-	--	-	100
ILO701X	Institute Level Optional Course-I	20	20	20	80	3	--	--	-	100
CSL701	Digital Signal & Image Processing Lab	-	-	-	-	-	25	--	--	25
CSL702	Mobile App. Development. Tech. Lab	-	-	-	-	-	25	--	25	50
CSL703	Artificial Intelligence & Soft Computing Lab	--	-	-	-	--	25	25	--	50
CSL704	Computational Lab-I						25	--	25	50
CSP705	Major Project-I	-	-	-	-	-	50	-	25	75
Total		100	100	100	400		150	25	75	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC801	Human Machine Interaction	4	-	-	4	-	-	4
CSC802	Distributed Computing	4	-	-	4	-	-	4
CSDLO 801X	Department Level Optional Course -IV	4	-	-	4	-	-	4
ILO801X	Institute Level Optional Course-II	3	-	-	3	-	-	3
CSL801	Human Machine Interaction Lab	-	2	-	-	1		1
CSL802	Distributed Computing Lab		2			1		1
CSL803	Cloud Computing Lab	-	4	-	-	2		2
CSL804	Computational Lab-II	-	2	-		1		1
CSP805	Major Project-II	-	12			6	-	6
	Total	**15**	**22**	-	**15**	**11**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab	-	-	-	-	-	25	25		50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50		50	100
Total		100	100	100	400	--	150		100	750

Sem.	Department Level Optional Course **(DLOC)**	**Institute Level Optional Course** **(ILOC)**
V	CSDLO5011: Multimedia System CSDLO5012: Advance Operating System CSDLO5013: Advance Algorithm	--------------------
VI	CSDLO6021: Machine Learning CSDLO6022: Advance Database System CSDLO6023: Enterprise Resource Planning CSDLO6024: Advance Computer Network	-------------------
VII	CSDLO7031: Advance System Security & Digital Forensics CSDLO7032: Big Data & Analytics CSDLO7033: Robotics	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering
VIII	DLO8011: High Performance Computing DLO8012: Natural Language Processing DLO8013: Adhoc Wireless Network	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Name	Credits
CSC301	Applied Mathematics-III	5

Course objectives:

1. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
2. To learn the complex mapping, standard mappings, cross ratios and fixed point.
3. To learn the Laplace Transform, Inverse Laplace Transform of various functions, its application and Z-transform.
4. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.

Course outcomes: On successful completion of course learner will be able to:

1. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
2. Plot the image of the curve by a complex transformation from z-plane to w-plane.
3. Expand the periodic function by using Fourier series and complex form of Fourier series.
4. Understand the concept of Laplace transform and inverse Laplace transform of various functions and its application to solve ordinary differential equations.
5. Apply the concept of Z- transformation and its inverse of the given sequence.
6. Apply the concept of Correlation and Regression to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Laplace Transform**	09
	1.1	**Laplace Transform of Standard Functions:** Introduction, Definition of Laplace transform, Laplace transform of $1, e^{at} \sin(at), \cos(at), \sinh(at), \cosh(at), t^n \, erf(t)$, Heavi-side unit step, dirac-delta function, LT of periodic function.	
	1.2	**Properties of Laplace Transform:** Linearity, first shifting property, second shifting property, multiplication by t^n, division by t, Laplace Transform of derivatives and integrals, change of scale property. (without proof)	
2.0		**Inverse Laplace Transform**	08
	2.1	Inverse Laplace Transform by Partial fraction method, Convolution theorem	
	2.2	Application to solve initial and boundary value problem involving	

		ordinary differential equations with one dependent variable and constant coefficients.	
3.0		**Fourier Series**	10
	3.1	Dirichlet's conditions, Fourier series of periodic functions with period 2π and $2L$, Fourier series for even and odd functions.	
	3.2	Half range sine and cosine Fourier series, Parsevel's identities (without proof)	
	3.3	Complex form of Fourier series, Orthogonal and Orthonormal set of functions.	
4.0		**Complex Variable & mapping**	09
	4.1	Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates & Polar co-ordinates.	
	4.2	Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories.	
	4.3	**Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles.	
5.0		**Z-transform**	06
	5.1	Z-transform of standard functions such as Z(a^n), Z(n^p).	
	5.2	Properties of Z-transform :Linearity, Change of scale, Shifting property, Multiplication of K, Initial and final value, Convolution theorem (without proof)	
	5.3	**Inverse Z transform:** Binomial Expansion and Method of Partial fraction	
6.0		**Correlation & regression, Curve Fitting**	10
	6.1	Scattered diagrams, Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation(non-repeated and repeated ranks)	
	6.2	Regression coefficient & Lines of Regression.	
	6.3	Fitting of curves: Least square method. Fitting of the straight line $y = a + bx$,parabolic curve $y = a + bx + cx^2$,& exponential curve $y = ab^x$	
		Total	**52**

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
4. J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
2. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
3. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgewar.
4. Laplace Transforms by Murry R. Spieget, Schaun's out line series-McGraw Hill Publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC302	**Digital Logic Design and Analysis**	**4**

Course Objectives:

1. To introduce the fundamental concepts and methods for design of digital circuits and a pre-requisite for computer organization and architecture, microprocessor systems.
2. To provide the concept of designing Combinational and sequential circuits.
3. To provide basic knowledge of how digital building blocks are described in VHDL.

Course Outcomes: At the end of the course student should be able-

1. To understand different number systems and their conversions.
2. To analyze and minimize Boolean expressions.
3. To design and analyze combinational circuits.
4. To design and analyze sequential circuits
5. To understand the basic concepts of VHDL.
6. To study basics of TTL and CMOS Logic families.

Module	Detailed Content	Hours
1	**Number Systems and Codes** Introduction to number system and conversions: Binary, Octal, Decimal and Hexadecimal number Systems, Binary arithmetic: addition, subtraction (1's and 2's complement), multiplication and division. Octal and Hexadecimal arithmetic: Addition and Subtraction (7's and 8's complement method for octal) and (15's and 16's complement method for Hexadecimal). Codes: Gray Code, BCD Code, Excess-3 code, ASCII Code. Error Detection and Correction: Hamming codes.	8
2	**Boolean Algebra and Logic Gates**: Theorems and Properties of Boolean Algebra, Boolean functions, Boolean function reduction using Boolean laws, Canonical forms, Standard SOP and POS form. Basic Digital gates: NOT , AND , OR , NAND , NOR , EXOR , EX-NOR, positive and negative logic, K-map method 2 variable, 3 variable, 4 variable, Don't care condition, Quine-McClusky Method, NAND-NOR Realization.	8
3	**Combinational Logic Design:** Introduction, Half and Full Adder, Half subtractor Full Subtractor, Four Bit Ripple adder, look ahead carry adder, 4 bit adder subtractor, one digit BCD Adder, Multiplexer, Multiplexer tree, Demultiplexer, Demultiplexer tree, Encoders Priority encoder, Decoders, One bit, Two bit , 4-bit Magnitude Comparator, ALU IC 74181.	8

4	**Sequential Logic Design**: Introduction: SR latch, Concepts of Flip Flops: SR, D, J-K, T, Truth Tables and Excitation Tables of all types, Race around condition, Master Slave J-K Flip Flops, Timing Diagram, Flip-flop conversion, State machines, state diagrams, State table, concept of Moore and Mealy machine. Counters : Design of Asynchronous and Synchronous Counters,Modulus of the Counters, UP- DOWN counter, Shift Registers: SISO, SIPO, PIPO, PISO Bidirectional Shift Register, Universal Shift Register, Ring and twisted ring/Johnson Counter, sequence generator.	15
5	**Introduction to VHDL:** Introduction: Fundamental building blocks Library, Entity, Architecture, Modeling Styles, Concurrent and sequential statements, simple design examples for combinational circuits and sequential circuits.	6
6	**Digital Logic Families**: Introduction: Terminologies like Propagation Delay, Power Consumption, Fan in and Fan out , current and voltage parameters, noise margin, with respect to TTL and CMOS Logic and their comparison	3

Text Books:

1. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
2. M. Morris Mano, “Digital Logic and computer Design”, PHI.
3. Norman Balabanian, “Digital Logic Design Principles”, Wiley.
4. J. Bhasker.“ VHDL Primer”, Pearson Education.

Reference Books:

1. Donald p Leach, Albert Paul Malvino,“Digital principles and Applications”,Tata McGraw
2. Yarbrough John M. , “Digital Logic Applications and Design “, Cengage Learning.
3. Douglas L. Perry, “VHDL Programming by Example”, Tata McGraw Hill.

Internal Assessment: Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC303	Discrete Mathematics	4

Course Objectives:

1. Cultivate clear thinking and creative problem solving.
2. Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3. Thoroughly prepare for the mathematical aspects of other Computer Engineering courses

Course Outcomes: At the end of the course student will be able to

1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2. Ability to reason logically.
3. Ability to understand relations, Diagraph and lattice..
4. Ability to understand use of functions, graphs and their use in programming applications.
5. Understand use of groups and codes in Encoding-Decoding
6. Apply discrete structures into other computing problems such as formal specification, verification, artificial intelligence, cryptography, Data Analysis and Data Mining etc.

Prerequisite: Basic Mathematics

Sr. No.	Module	Detailed Content	Hours
1	Set Theory	• Sets, Venn diagrams, Operations on Sets • Laws of set theory, Power set and Products • Partitions of sets, The Principle of Inclusion and Exclusion	4
2	Logic	• Propositions and logical operations, Truth tables • Equivalence, Implications • Laws of logic, Normal Forms • Predicates and Quantifiers • Mathematical Induction	8
3	Relations and Functions	• Relations, Paths and Digraphs • Properties and types of binary relations • Operations on relations, Closures, Warshall's algorithm • Equivalence and partial ordered relations, • Poset, Hasse diagram and Lattice • Functions: Types of functions - Injective, Surjective and Bijective	12

		• Composition of functions , Identity and Inverse function • Pigeon-hole principle	
4	Counting	• Permutations , Combinations • Elements of Probability, Discrete Probability and Conditional Probability • Generating Functions and Recurrence Relations • Recursive Functions • Introduction to Functional Programming	6
5	Graphs	• Definitions, Paths and circuits: Eulerian and Hamiltonian • Types of graphs, Sub Graphs • Isomorphism of graphs	6
6	Algebraic Structures and Coding Theory	• Algebraic structures with one binary operation: semigroup, monoid and group, Abelian group • Isomorphism, Homomorphism and Automorphism • Cyclic groups, Normal subgroups, • Codes and group codes	8

Text Books:

1. BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “Discrete Mathematical Structures”, Pearson Education.
2. C.L.Liu, Elements of Discrete Mathematics, second edition 1985, McGraw-Hill BookCompany. Reprinted 2000.
3. K.H.Rosen, Discrete Mathematics and applications, fifth edition 2003, TataMcGraw Hill publishing Company.
4. D.E. Rydeheard University of Manchester , R.M. Burstall, University of Edinburgh “Computational Category Theory”.

Reference Books:

1. Y N Singh, “Discrete Mathematical Structures”, Wiley-India.
2. J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.
3. J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, TataMcgraw-Hill.
4. Seymour Lipschutz , Marc Lars Lipson,“ Discrete Mathematics” Schaum’sOutline, McGraw Hill Education.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

**** Tutorial lecture can be conducted for each unit and min 10 problems on the covered unit can be given to the students for practice.**

Course Code	Course Name	Credits
CSC304	**Electronic Circuits and Communication Fundamentals**	**4**

Course Objectives:

1. To develop the knowledge of semiconductor devices and circuits, and explain their use in communication applications.
2. To inculcate circuit analysis capabilities in students.
3. To gain knowledge in electronic devices and circuits that is useful in real life applications.
4. To understand the fundamental concepts of electronic communication and their use in computer applications.

Course Outcomes: At the end of the course student should be able

1. To understand the use of semiconductor devices in circuits and analyze them.
2. To understand importance of oscillators and power amplifiers in communication system.
3. To understand basic concepts of operational amplifier and their applications.
4. To understand the fundamental concepts of electronic communication
5. To apply knowledge of electronic devices and circuits to communication applications.
6. To study basic concepts of information theory.

Prerequisite: Basic electrical engineering

Module	Detailed Content	Hours
1	**Electronic Circuits:Bipolar junction transistor**. Input and Output characteristics, Types of Biasing - Fixed bias, self-bias, voltage divider bias, DC load line and significance, CE amplifier using re model, (Analysis based Numericals)	08
2	**Power Amplifiers:** Introduction, Class A and Class C power amplifier. Oscillators: Introduction, Barkhausen criteria, Colpitts oscillator and Crystal oscillator	04
3	**Electronic Circuits** : **Operational Amplifier and its applications** Op-amp – block diagram, parameters and characteristics, applications-Inverting and Non inverting amplifier, Summing Amplifier(Numerical), Difference amplifier, Basic Integrator and Differentiator, Comparator, Zero Crossing Detector (only theory)	10

4	**Communication Fundamentals: Analog Communication** Block diagram and elements of analog communication systems, Theory of amplitude modulation and types of AM (Numerical) Generation of DSB SC using diode based balanced modulator, Generation of SSB using phase shift method, Introduction of FM,and its mathematical representation, Statement of Carson's Rule Comparison of AM, FM, Block diagram of AM transmitter (HLM and LLM) Block diagram of AM Superheterodyne receiver.	10
5	**Pulse Modulation and Multiplexing.** Statement of Sampling Theorem, Generation and detection of PAM, PWM, PPM, PCM, DM and ADM. Principle of TDM using PCM and FDM	10
6	**Communication Fundamentals**: **Information theory.** Amount of information, average information, information rate, Statement of Shannon's theorem, channel capacity (Numericals)	06

Text Books:

1. Robert Boylestad, 'Electronic Devices and circuit Theory', Prentice Hall.
2. D Roy Choudhury, ' Linear integrated Circuits' New Age International Ltd
3. G. Kennedy, B. Davis, S R M Prasanna, 'Electronic Communication Systems', McGraw Hill, 5th Edition.
4. Wayne Tomasi, 'Electronic Communication Systems (fundamentals through advanced)', Pearson Education, 4th Edition.
5. K. Sam Shanmugam,' Digital and analog communication systems', Wiley.

Reference Books:

1. Donald Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill,2nd Edition.
2. K. R. Botkar, 'Integrated Circuits', Khanna Publishers, 9th Edition
3. Simon Haykin, 'Digital Communication systems', Wiley.
4. David Bell, 'Electronic Devices and Circuits', Oxford, 5th Edition.
5. Ramakant A. Gayakwad, 'Op-amp and linear integrated circuits', PHI, 3rd edition.

Internal Assessment

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

2 Question paper will comprise of 6 questions, each carrying 20 marks.
5. The students need to solve total 4 questions.
6. Question No.1 will be compulsory and based on entire syllabus.
7. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC305	**Data Structures**	**4**

Course Objectives:

1. To teach various storage mechanisms of data.
2. To design and implement various data structures.
3. To introduce various techniques for representation of the data in the real world.
4. To teach different sorting techniques.
5. To teach different searching techniques.

Course Outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.
3. Students will be able to select appropriate sorting technique for given problem.
4. Students will be able to select appropriate searching technique for given problem.
5. Students will be able to apply the learned concepts in various domains like DBMS and Compiler Construction.
6. Students will be able to choose appropriate data structure for specified problem domain.

Prerequisite: C Programming

Module	Detailed Content	Hours
01	**Introduction to Data Structures**	03
	Introduction, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of ADT, Arrays.	
02	**Stack and Queues**	10
	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion. ADT of Queue, Operations on Queue, Array Implementation of Queue, Circular Queue, Priority Queue, Double Ended Queue, Applications of Queue.	
03	**Linked List**	10
	Introduction, Representation of Linked List, Linked List v/s Array, Implementation of Linked List, Linked Implementation of Stack and Queue, Circular Linked List, Doubly Linked List, Application – Polynomial Representation and Addition.	
04	**Trees**	12
	Introduction, Tree Terminologies, Binary Tree, Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Implementation of Binary Search Tree, Applications – Expression Tree, Huffman Encoding. Search Trees – AVL, B Tree, B+ Tree, Splay Tree and Trie.	

05	**Graphs**	06
	Introduction, Graph Terminologies, Representation, Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting	
06	**Sorting and Searching**	07
	Introduction, Bubble Sort, Insertion Sort, Merge Sort, Quick Sort. Linear Search, Binary Search, Hashing – Concept, Hash Functions, Collision Handling Techniques.	

Text Books:

1. Data Structures using C, Reema Thareja, Oxford
2. Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3. Data Structures Using C, Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson
4. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A., Forouzan, Second Edition, CENGAGE Learning
5. Introduction to Data Structure and Its Applications, JeanPaul Tremblay, P. G. Sorenson

Reference Books:

1. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, DreamTech press.
2. Data Structure Using C, Balagurusamy.
3. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
4. Data Structures, Adapted by: GAV PAI, Schaum’s Outlines.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules

Lab Code	Lab Name	Credits
CSL301	**Digital System Lab**	**1**

Lab Outcome:

1. Understand the basics of various digital components.
2. Understand the principles of design of combinational logic and sequential logic circuits using basic components.
3. Recognize the importance of digital systems in computer architecture.
4. Design and simulate the basic digital circuit.

Description

Experiments with Logic Building Blocks using SSI/MSI, Experiments on Design and/or use Minimization tools. Use of VHDL and simulation in Logic Design. Experiment on design using MSI and/or PLDs tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	To study and verify the truth table of various logic gates using ICs and realize Boolean expressions using gates
2	To realize basic gates using universal gates
4	To realize binary to gray code and gray code to binary converter.
5	To realize parity generator and detector.
6	To realize arithmetic circuits i) Half adder ii) Full adder iii) Half subtractor iv) Full subtractor
7	To realize 2 bit magnitude comparator.
8	To Study multiplexer IC and realization of full adder using multiplexer IC
9	To Study decoder IC and realization of combinational logic using decoder IC
10	Study of flip-flops using IC's
11	To realize asynchronous 3 bit up counter.
12	To realize shift registers using flip flops
13	To realize basic gates using VHDL

14	To realize 4:1 multiplexer using VHDL
15	To realize 4 bit counter using VHDL

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral & Practical exam will be based on the above and CSC302: Digital Logic Design and Analysis syllabus.

Lab Code	Lab Name	Credits
CSL302	**Basic Electronics Lab**	**1**

Lab Outcome:

1. Understand the basics of various semiconductor devices, electronic components and instruments.
2. Understand the working of electronic circuits using components
3. Recognize the importance of electronic circuits in electronic communications.
4. Study the fundamental concepts of various modulation methods.

Description

Experiments with semiconductor devices, ICs, electronic component and various measuring instruments. Study experiments on various modulation methods.

Suggested List of Experiments:

Sr. No.	List Experiments
1	Study of electronic components and measuring instruments.
2	Implementation of single stage BJTamplifier.
3	Implementation of oscillators.
4	Implementation of inverting, non inverting amplifier using IC741.
5	Implementation of adder and subtractor using IC 741.
6	Implementation of differentiator using IC741.
7	Implementation of integrator using IC741.
8	Modulation and Demodulation of AM.
9	Study of super heterodyne receiver
10	Modulation and Demodulation PAM.
11	Modulation and Demodulation PWM.
12	Modulation and Demodulation PPM.
13	Modulation and Demodulation PCM.
14	Study of TDM.

15	Study of FDM.
16	SPICE based simulation.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral exam will be based on the above mentioned experiment list and CSC304: Electronic circuits and communication fundamentals syllabus.

Lab Code	Lab Name	Credits
CSL303	**Data Structures Lab**	**1**

Lab outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.

Description: Experiments based on creating and manipulating various data structures.

Suggested Experiments:

Students are required to complete at least 12 experiments.
Star (*) marked experiments are compulsory.

*1) Array Implementation of Stack.

*2) Conversion of Infix to Postfix.

3) Evaluation of Postfix Expression.

4) Check continuity of different types of parenthesis using stack.

5) Array Implementation of Queue.

*6) Array Implementation of Circular Queue.

7) Array Implementation of Priority Queue

*8) Implementation of Singly Linked List

9) Linked Implementation of Stack

10) Linked Implementation of Queue.

11) Implementation of Circular Linked List.

12) Implementation of Doubly Linked List.

*13) Implement Binary Search Tree.

14) Implementation of Bubble Sort.

15) Implementation of Insertion Sort.

16) Implementation of Merge Sort.

*17) Implementation of Quick Sort.

*18) Implementation of Binary Search.

19) Implementation of Hashing.

20) Implementation of Depth First Search and Breadth First Search.

Term Work:

1. Term work should consist of at least 10 experiments.
2. Journal must include at least 2 assignments.
3. A case study should be conducted using a Mini Project by taking a good problem definition and complete the following phases.
    a. Decomposing the problem into modules
    b. Identifying the best suited data structure for solving the sub problems with justification
    c. Define algorithms for various identified functions
    d. Implement the modules
4. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5. Term Work:

Total 25 Marks = (Experiments: 10 mark + Mini Project: 05 mark + Assignments: 05 mark)

Practical and oral examination will be based on the above syllabus.

Lab Code	Lab Name	Credits
CSL304	**OOPM (JAVA) Lab**	**2**

Course Objective:

1. To learn the object oriented programming concepts.
2. To study various java programming concept like multithreading, exception handling, packages etc.
3. To explain components of GUI based programming.

Course Outcomes: At the end of the course Student should be able:

1. To apply fundamental programming constructs.
2. To illustrate the concept of packages, classes and objects.
3. To elaborate the concept of strings, arrays and vectors.
4. To implement the concept of inheritance and interfaces.
5. To implement the notion of exception handling and multithreading.
6. To develop GUI based application.

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Object Oriented Programming	1.1 OOP Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. 1.2 Features of Java, JVM 1.3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	02
2	Classes, Object and Packages	2.1Class, Object, Method. 2.2 Constructor, Static members and methods 2.3 Passing and returning Objects 2.4Method Overloading 2.5 Packages in java, creating user defined packages, access specifiers.	05
3	Array, String and Vector	3.1 Arrays, Strings, String Buffer 3.2 Wrapper classes, Vector	04
4	Inheritance and Interface	4.1Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, 4.2 Implementing interfaces, extending interfaces	03
5	Exception Handling and Multithreading	5.1 Error vs Exception, try, catch, finally, throw, throws, creating own exception 5.2 Thread lifecycle, Thread class methods, creating threads, Synchronization	04
6	GUI programming in JAVA	6.1 Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing.	08

		6.2 Event Handling: Event classes and event listener 6.3 Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons. 6.4 Programming using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e,PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.
4. 'Learn to Master Java programming', Staredusolutions

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested List of Programming Assignments/Laboratory Work:

1.	Program on various ways to accept data through keyboard and unsigned right shift operator.
2.	Program on branching, looping, labelled break and labelled continue.
3.	Program to create class with members and methods, accept and display details for single object.
4.	Program on constructor and constructor overloading
5.	Program on method overloading
6.	Program on passing object as argument and returning object
7.	Program on creating user defined package
8.	Program on 1D array
9.	Program on 2D array

10.	Program on String
11.	Program on StringBuffer
12.	Program on Vector
13.	Program on single and multilevel inheritance (Use super keyword)
14.	Program on abstract class
15.	Program on interface demonstrating concept of multiple inheritance
16.	Program on dynamic method dispatch using base class and interface reference.
17.	Program to demonstrate try, catch, throw, throws and finally.
18.	Program to demonstrate user defined exception
19.	Program on multithreading
20.	Program on concept of synchronization
21.	Program on Applet to demonstrate Graphics, Font and Color class.
22.	Program on passing parameters to applets
23.	Program to create GUI application without event handling using AWT controls
24.	Program to create GUI application with event handling using AWT controls
25.	Mini Project based on content of the syllabus. (Group of 2-3 students)

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 16-18 programs and mini project
2. Two assignments covering whole syllabus

Term Work: 50 Marks (Total Marks) = 20 marks (Experiments) +
20 marks (Mini Project) +
05 marks (Assignments) +
05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Credits
CSC401	**Applied Mathematics-IV**	**5**

Course Objectives: The objectives of this course are to teach the students:

1. Matrix theory, and it's application to find the matrix function. Present methods of computing and using Eigen values and Eigen vectors.
2. Set up and directly evaluate contour integrals Cauchy's integral theorem and formula in basic and extended form. Present Taylor and Laurent's series to find singularities zero's and poles also presents residues theory
3. Theory of probability, Baye's Theorem, Expectation and Moments and it's application.
4. Probability distribution such as Binomial, Poisson and Normal distribution with their properties.
5. Sampling theory and it's application for small and large sample and Optimization techniques.

Course Outcomes:

1. Students in this course will be able to apply the method of solving complex integration, computing residues & evaluate various contour integrals.
2. Demonstrate ability to manipulate matrices and compute Eigen values and Eigen vectors.
3. Apply the concept of probability distribution to the engineering problems.
4. Apply the concept of sampling theory to the engineering problems.
5. Use matrix algebra with its specific rules to solve the system of linear equation, using concept of Eigen value and Eigen vector to the engineering problems.
6. Apply the concept of Linear & Non-Linear Programming Problem to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Complex Integration**	**10**
	1.1	Complex Integration – Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula(without proof)	
	1.2	Taylor's and Laurent's series (without proof)	
	1.3	Zeros, poles of f(z), Residues, Cauchy's Residue theorem.	
	1.4	Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta) d\theta$, $\int_{-\infty}^{\infty} f(x) dx$	
2.0		**Matrices**	**10**
	2.1	Eigen values and Eigen vectors.	
	2.2	Cayley-Hamilton theorem(without proof)	
	2.3	Similar matrices, diagonalisable matrix.	
	2.4	Derogatory and non-derogatory matrices, Functions of square matrix.	

3.0		**Probability**	**10**
	3.1	Baye’s Theorem	
	3.2	**Random Variables:** Discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function.	
	3.3	Moments & Moment generating function.	
	3.4	**Probability distribution:** Binomial distribution, Poisson & Normal distribution. (For detail study)	
4.0		**Sampling Theory (Large Sample test)**	**06**
	4.1	Sampling Distribution, Test of Hypothesis, Level of significance, Critical region, One Tailed and Two Tailed test,	
	4.2	Test of significant for Large Samples:-Means of the samples and test of significant of means of two large samples.	
5.0		**Sampling Theory (Small Sample test)**	**06**
	5.1	Test of significant for small samples:- Students t- distribution for dependent and independent samples	
	5.2	Chi square test:- Test of goodness of fit and independence of attributes,Contingency table.	
6.0		**Mathematical Programming**	**10**
	6.1	Types of solution, Standard and Canonical form of LPP, Basic and feasible solutions, simplex method.	
	6.2	Artificial variables, Big –M method (method of penalty).	
	6.3	Duality and Dual simplex method.	
	6.4	Non Linear Programming Problems with equality constrains and inequality Constrains (two or three variables with one constrains) (No formulation, No Graphical method).	
		Total	**52**

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Operation Research by Hira & Gupta,S Chand.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
4. J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
5. Probability and Statistics for Engineering, Dr. J Ravichandran, Wiley-India.

Reference Books:

1. Probability & Statistics with reliability by Kishor s. Trivedi, Wiley India.
2. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
3. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
4. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
5. Operations Research by S.D. Sharma Kedar Nath, Ram Nath & Co. Meerat.
6. Engineering optimization (Theory and Practice) by Singiresu S.Rao, New Age International publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSC402	**Analysis of Algorithms**	**4**

Course Objectives:

4. To provide mathematical approach for Analysis of Algorithms
5. To solve problems using various strategies
6. To analyse strategies for solving problems not solvable in polynomial time.

Course Outcomes: At the end of the course student will be able to

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the complexity of greedy strategy.
4. Describe, apply and analyze the complexity of dynamic programming strategy.
5. Explain and apply backtracking, branch and bound and string matching techniques to deal with some hard problems.
6. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

Prerequisites: Students should be familiar with concepts of Data structure and discrete structures.

Module	Detailed Content	Hours
1	**Introduction to analysis of algorithm** Performance analysis , space and time complexity Growth of function – Big –Oh ,Omega , Theta notation Mathematical background for algorithm analysis, Analysis of selection sort , insertion sort. **Recurrences:** -The substitution method -Recursion tree method -Master method **Divide and Conquer Approach:** General method Analysis of Merge sort, Analysis of Quick sort, Analysis of Binary search, Finding minimum and maximum algorithm and analysis, Strassen's matrix multiplication	12
2	**Dynamic Programming Approach:** General Method Multistage graphs single source shortest path all pair shortest path Assembly-line scheduling 0/1 knapsack Travelling salesman problem Longest common subsequence	08
3	**Greedy Method Approach:**	06

	General Method Single source shortest path Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and prim's algorithm Optimal storage on tapes	
4	**Backtracking and Branch-and-bound:** General Method 8 queen problem(N-queen problem) Sum of subsets Graph coloring 15 puzzle problem, Travelling salesman problem.	08
5	**String Matching Algorithms:** The naïve string matching Algorithms The Rabin Karp algorithm String matching with finite automata The knuth-Morris-Pratt algorithm	06
6	**Non-deterministic polynomial algorithms:** Polynomial time, Polynomial time verification NP Completeness and reducibility NP Completeness proofs Vertex Cover Problems Clique Problems	08

Text Books:

1. T.H.coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, “Introduction to algorithms”, 2nd edition , PHI publication 2005.
2. Ellis horowitz , Sartaj Sahni , S. Rajsekaran. “Fundamentals of computer algorithms” University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw- Hill Edition.
2. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI.
3. John Kleinberg, Eva Tardos, “Algorithm Design”, Pearson.
4. Michael T. Goodrich, Roberto Tamassia, “Algorithm Design”, Wiley Publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules**..**

Course Code	Course Name	Credit
CSC403	**Computer Organization and Architecture**	**4**

Course Objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To discuss in detail the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
3. To study the different ways of communicating with I/O devices and standard I/O interfaces.
4. To study the hierarchical memory system including cache memories and virtual memory.

Course Outcomes: At the end of the course student should be able-

1. To describe basic structure of the computer system.
2. To demonstrate the arithmetic algorithms for solving ALU operations.
3. To describe instruction level parallelism and hazards in typical processor pipelines.
4. To describe superscalar architectures, multi-core architecture and their advantages
5. To demonstrate the memory mapping techniques.
6. To Identify various types of buses, interrupts and I/O operations in a computer system

Prerequisite: Digital Logic Design and Application

Sr. No.	Module	Detailed Content	Hours
1	Introduction	Overview of Computer Architecture & Organization • Introduction • Basic organization of computer • Block level description of the functional units. Data Representation and Arithmetic Algorithms: • Integer Data computation: Addition, Subtraction. Multiplication: unsigned multiplication, Booth's algorithm. • Division of integers: Restoring and non restoring division • Floating point representation. IEEE 754 floating point number representation. • Floating point arithmetic: Addition, Subtraction, Multiplication, Division	08
2	Processor Organization and Architecture	• Von Neumann model, Harvard Architecture • Register Organization, Instruction formats, addressing modes, instruction cycle. Instruction interpretation and sequencing. • ALU and Shifters • Basic pipelined datapath and control, Data dependences, data hazards, Branch hazards, delayed branches, branch prediction • Performance measures – CPI, speedup, efficiency, throughput and Amdahl's law	10

3	Control Unit Design	• Hardwired control unit design methods: State table, delay element, sequence counter with examples like control unit for multiplication and division • Microprogrammed control Unit: Microinstruction sequencing and execution. Micro operations, Wilkie's microprogrammed Control Unit, Examples on microprograms	08
4	Memory Organization	• Classifications of primary and secondary memories. Types of RAM (SRAM, DRAM, SDRAM, DDR, SSD) and ROM, Characteristics of memory, Memory hierarchy: cost and performance measurement. • Virtual Memory: Concept, Segmentation and Paging, Address translation mechanism. • Interleaved and Associative memory. • Cache memory Concepts, Locality of reference, design problems based on mapping techniques. Cache Coherency, Write Policies	12
5	I/O Organization and Peripherals	• Common I/O device types and characteristics • Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA. • Introduction to buses, Bus arbitration and multiple bus hierarchy • Interrupt types, Interrupts handling	06
6	Advanced Processor Principles	• Introduction to parallel processing, Flynn's Classification • Concepts of superscalar architecture, out-of-order execution, speculative execution, multithreaded processor, VLIW, data flow computing. • Introduction to Multi-core processor architecture	08

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Publication, 10th Edition, 2013
2. John P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1988
3. B. Govindarajulu, "Computer Architecture and Organization: Design Principles and Applications", Second Edition, McGraw-Hill (India),

Reference Books:

1. Andrew S. Tanenbaum "Structured Computer Organization", Pearson, Sixth Edition
2. Morris Mano. "Computer System Architecture" Pearson Publication, 3rd Edition, 2007
3. Kai Hwang, Fayé Alayé Briggs. "Computer architecture and parallel processing", McGraw-Hill
4. P. Pal Chaudhuri. "Computer Organization and Design" Prentice Hall India, 2004
5. Dr. M. Usha, T.S. Shrikant. "Computer System Architecture and Organization" Wiley India, 2014.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC404	**Computer Graphics**	**4**

Course Objectives

1. To equip students with the fundamental knowledge and basic technical competence in the field of computer graphics.
2. To emphasize on implementation aspect of Computer Graphics Algorithms.
3. To prepare the student for advance areas like Image Processing or Computer Vision or Virtual Reality and professional avenues in the field of Computer Graphics.

Course Outcomes : At the end of the course , the students should be able to

1. Understand the basic concepts of Computer Graphics.
2. Demonstrate various algorithms for scan conversion and filling of basic objects and their comparative analysis.
3. Apply geometric transformations, viewing and clipping on graphical objects.
4. Explore solid model representation techniques and projections.
5. Understand visible surface detection techniques and illumination models.

Prerequisite: Knowledge of C Programming, Basic Data Structures and Mathematics**.**

Module No	Detail Syllabus	Hours
1	**Introduction and Overview of Graphics System**: • Definition and Representative uses of computer graphics, classification of application areas, Overview of coordinate systems ,definition of scan conversion, rasterization and rendering. • Raster scan & random scan displays, Flat Panel displays like LCD and LED , architecture of raster graphics system with display processor, architecture of random scan systems.	03
2	**Output Primitives** : • Scan conversions of point,line, circle and ellipse : DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected) • Aliasing , Antialiasing techniques like Pre and post filtering , super sampling , and pixel phasing). • Filled Area Primitive: Scan line Polygon Fill algorithm, Inside outside tests, Boundary Fill and Flood fill algorithm.	12
3	**Two Dimensional Geometric Transformations** • Basic transformations : Translation , Scaling , Rotation • Matrix representation and Homogeneous Coordinates • Composite transformation • Other transformations : Reflection and Shear • Raster method for transformation.	06

4	**Two Dimensional Viewing and Clipping** • Viewing transformation pipeline and Window to Viewport coordinate transformation • Clipping operations – Point clipping , Line clipping algorithms : Cohen – Sutherland , Midpoint subdivision , Liang – Barsky , Polygon Clipping Algorithms : Sutherland – Hodgeman, Weiler – Atherton.	08
5	**Three Dimensional Object Representations , Geometric Transformations and 3D Viewing** • Boundary Representation and Space partitioning representation: Polygon Surfaces , Bezier Curve , Bezier Surface , B-Spline Curve , Sweep Representation, Constructive Solid Geometry ,Octree, Fractal-Geometry : Fractal Dimension, Koch Curve. • 3D Transformations :Translation, Rotation , Scaling and Reflection. • Composite transformations :Rotation about an arbitrary axis • 3D transformation pipeline • Projections – Parallel , Perspective.(Matrix Representation) • 3D clipping.	12
6	**Visible Surface Detection** • Classification of Visible Surface Detection algorithm • Back Surface detection method • Depth Buffer method • Depth Sorting method • Scan line method • Area Subdivision method	04
7	**Illumination Models and Surface Rendering** • Basic Illumination Models : Diffused reflection, Phong Specular reflection Model • Halftone and Dithering techniques • Polygon Rendering :Constant shading , Gouraud Shading , Phong Shading.	03

Text Books:

1. “Computer Graphics” C version by Hearn & Baker, 2nd Edition, Pearson
2. “Computer Graphics Principles and Practice in C , 2nd Edition ,James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Pearson .
3. “Computer Graphics”, by Rajesh K. Maurya, Wiley India Publication.
4. “Computer Graphics “ , by Samit Bhattacharya , Oxford Publication.

Reference Books:

1. "Procedural Elements for Computer Graphics " by D. Rogers , Tata McGraw-Hill Publications.
2. "Computer Graphics" , by Zhigang Xiang , Roy Plastock , Schaum's Outlines McGraw-Hill Education
3. "Computer Graphics using OpenGL" , by F.S.Hill , Jr. ,Third edition, Pearson Publications.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC405	**Operating System**	**4**

Course Objectives:

1. To introduce basic concepts and functions of operating systems.
2. To understand the concept of process, thread and resource management.
3. To understand the concepts of process synchronization and deadlock.
4. To understand various Memory, I/O and File management techniques.

Course Outcomes: At the end of the course student should be able to

1. Understand role of Operating System in terms of process, memory, file and I/O management.
2. Apply and analyse the concept of a process, thread, mutual exclusion and deadlock.
3. Evaluate performance of process scheduling algorithms and IPC.
4. Apply and analyse the concepts of memory management techniques.
5. Evaluate the performance of memory allocation and replacement techniques.
6. Apply and analyze different techniques of file and I/O management.

Prerequisite: Computer Organization & Architecture

Sr No	Module	Detailed Content	Hours
1	**Operating System Overview**	Operating System Objectives and Functions, The Evolution of Operating Systems, OS Design Considerations for Multiprocessor and Multicore architectures, Operating system structures, System Calls, Linux Kernel and Shell.	8 hrs
2	**Process Concept and Scheduling**	**Process:** Concept of a Process, Process States, Process Description, Process Control Block, Operations on Processes. **Threads**: Definition and Types, Concept of Multithreading, Multicore processors and threads. **Scheduling:** Uniprocessor Scheduling - Types of Scheduling: Preemptive and, Non-preemptive, Scheduling Algorithms: FCFS, SJF, SRTN, Priority based, Round Robin, Multilevel Queue scheduling. Introduction to Thread Scheduling, Multiprocessor Scheduling and Linux Scheduling.	8 hrs

3	**Synchronization and Deadlocks**	**Concurrency**: Principles of Concurrency, Inter-Process Communication, Process/Thread Synchronization. **Mutual Exclusion**: Requirements, Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors), Classical synchronization problems: Readers/Writers Problem, Producer and Consumer problem. **Principles of Deadlock**: Conditions and Resource Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm for Single & Multiple Resources, Deadlock Detection and Recovery. Dining Philosophers Problem.	12 hrs
4	**Memory Management**	**Memory Management**: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Next Fit, Buddy System, Relocation. Paging, Segmentation. **Virtual Memory**: Hardware and Control Structures, Demand Paging, Structure of Page Tables, Copy on Write, Page Replacement Strategies: FIFO, Optimal, LRU, LFU, Approximation, Counting Based. Allocation of frames, Thrashing.	8 hrs
5	**File Management**	**File Management**: Overview, File Organization and Access, File Directories, File Sharing, Secondary Storage Management, Linux Virtual File System.	6 hrs
6	**Input /Output Management**	**I/O Management and Disk Scheduling**: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling algorithm: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK. Disk Management, Disk Cache, Linux I/O.	6 hrs

Text Books:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918 .
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons , Inc., 9th Edition, 2016, ISBN 978-81-265-5427-0
3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition.
4. D.M Dhamdhere, Operating Systems: A Concept Based Approach, Mc-Graw Hill

Reference Books:

1. Maurice J. Bach, "Design of UNIX Operating System", PHI
2. Achyut Godbole and Atul Kahate, Operating Systems, Mc Graw Hill Education, 3rd Edition
3. The Linux Kernel Book, Remy Card, Eric Dumas, Frank Mevel, Wiley Publications.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credit
CSL401	**Analysis of Algorithms Lab**	**1**

Lab outcomes: At the end of the course student will be able to

1. Analyze the complexities of various problems in different domains.
2. Prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.
3. Develop the efficient algorithms for the new problem with suitable designing techniques.
4. Implement the algorithms using different strategies.

Prerequisites: Students should be familiar with concepts of Data structure and Discrete structures.

Description:

Minimum 2 experiments should be implemented using any language on each algorithm design strategy (Divide and conquer, dynamic programming, Greedy method, backtracking and branch & bound, string matching).

Suggested Laboratory Experiments:

Sr. No.	Module Name	Suggested Experiment List
1	Introduction to analysis of algorithm Divide and Conquer Approach	Selection sort , insertion sort. Merge sort, Quick sort, Binary search.
2	Dynamic Programming Approach	Multistage graphs, single source shortest path, all pair shortest path, 0/1 knapsack, Travelling salesman problem, Longest common subsequence.
3	Greedy Method Approach	Single source shortest path, Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees-Kruskal and prim's algorithm, Optimal storage on tapes.
4	Backtracking and Branch-and-bound	8 queen problem (N-queen problem), Sum of subsets, Graph coloring, 15 puzzle problem, Travelling salesman problem.

5	String Matching Algorithms	The naïve string matching Algorithms, The Rabin Karp algorithm, String matching with finite automata, The knuth-Morris-Pratt algorithm.
6	Any two Experiments	This will involve implementation of two algorithms for problems beyond the scope of syllabus. The exact set of algorithms to implement is to be decided by the course instructor.

Text Books:

1. T.H.Coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, “Introduction to algorithms”, 2nd edition , PHI publication 2005.
2. Ellis horowitz , sartaj Sahni , s. Rajsekaran. “Fundamentals of computer algorithms” University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw- Hill Edition.
2. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI.
3. Dana Vrajittoru and William Knight, “Practical Analysis of Algorithms”, Springer 2014th Edition.

Term Work:

Laboratory work must contain implementation of minimum 10 experiments. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work. The 25 marks of the term work should be divided as below:
25 Marks (total marks) = 15 Marks Lab. Experiments + 05 Marks Assignments (based on theory syllabus) + 05 (Attendance: theory + practical)

Oral & Practical Exam will be based on the experiments implemented in the Laboratory.

Lab Code	Lab Title	Credit
CSL402	**Computer Graphics Lab**	**1**

Lab Objectives

1 To emphasize on implementation aspect of Computer Graphics Algorithm.
2 To prepare students for advanced areas like Animation, image processing ,virtual reality etc

Lab Outcomes : At the end of the course , the students should be able to

1 Explore the working principle, utility of various input/ output devices and graphical tools.
2 Implement various output and filled area primitive algorithms using C/ OpenGL
3 Apply transformation and clipping algorithms on graphical objects.
4 Implementation of curve and fractal generation.
5 Develop a Graphical application based on learned concept.

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation. Curves. Visible surface determination. Simple animations Application of these through exercises in C/C++/ Open GL

List of Desirable Experiments:

1. Study and apply basic opengl functions to draw basic primitives. (*)
2. Implement sierpinsky gasket using openGL.
3. Implement DDA Line Drawing algorithms and Bresenham algorithm(*)
4. Implement midpoint Circle algorithm(*)
5. Implement midpoint Ellipse algorithm
6. Implemen tArea Filling Algorithm: Boundary Fill, Flood Fill ,Scan line Polygon Fill (*)
7. Implement Curve : Bezier for n control points , B Spline (Uniform) (atleast one)(*)
8. Implement Fractal (Koch Curve)
9. Character Generation : Bit Map method and Stroke Method
10. Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.(*)
11. Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.(*)
12. Implement polygon clipping algorithm(atleast one)
13. Program to represent a 3D object using polygon surfaces and then perform 3D transformation.
14. Program to perform projection of a 3D object on Projection Plane : Parallel and Perspective.(*)

Term Work

1. Term work should consist of at least 12 experiments. (*)→ Practical to be covered necessarily
2. Journal must include at least 2 assignments.
3. Mini Project to perform using C / OpenGL.
   Possible Ideas:
   a. Animation using multiple object
   b. Graphics editor with following features :
      *Draw basic geometrical entities; apply geometrical transformations, Area filling, Clipping against Clip window, displaying the text, displaying bar / line graphs , pie charts etc.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC404: Computer Graphics.

Lab Code	Lab Name	Credit
CSL403	**Processor Architecture Lab**	**1**

Lab Objectives:

1. To implement the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
2. To study the different ways of communicating with I/O devices and standard I/O interfaces.
3. To design memory subsystem including cache memory
4. To have through understanding of various computer buses

Lab Outcomes: At the end of the course student should be

1. Assemble personal computer
2. Design the basic building blocks of a computer: arithmetic-logic unit, registers, central processing unit, and memory.
3. Implement various algorithms like Booth's algorithm for arithmetic operations
4. Describe various I/O buses with merits and demerits.

Prerequisite: Digital Logic Design and Applications

Content:

Sr. No.	**Module**	**Detailed Content**
1	Overview of Computer Architecture & Organization	• Computer Anatomy- Memory, Ports, Motherboard and add-on cards • Dismantling and assembling PC
2	Programs on Data Representation and Arithmetic	• Ripple carry adder, Carry look-ahead adder, registers, Multiplication • Booths Algorithm, Restoring and Non restoring Division
3	Processor Organization and Architecture	• ALU Design, CPU Design • Case Study on multi-core Processors
4	Memory Organization	• Memory design, Cache Memory design
5	I/O Organization and Interrupts	• Case study on buses like ISA, PCI, USB etc • Interrupt handling using C/Java Programming

Digital Material:

- **Manual to use the simulator for computer organization and architecture.** Developed by the Department of CSE, IIT kharagpur (http://cse10-iitkgp.virtual-labs.ac.in/)

Books:

1. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Pearson Publication, 10th Edition, 2013
2. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, McGraw-Hill (India),
6. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition
7. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007
8. Kai Hwang, Fayé Alayé Briggs. “Computer architecture and parallel processing”, McGraw-Hill
9. P. Pal Chaudhuri. “Computer Organization and Design” Prentice Hall India, 2004
10. Dr. M. Usha, T.S. Shrikant. “Computer System Architecture and Organization” Wiley India, 2014.

Term Work

Term work should consist of at least 10-12 experiments and 3-4 assignments based on above content and CSC403: Computer Organization and Architecture

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral exam will be based on the above content and CSC403: Computer Organization and Architecture.

Lab Code	Lab Name	Credit
CSL404	**Operating System Lab**	**1**

Lab Outcome:

1. Understand basic operating system commands.
2. Understand and explore various system calls.
3. Write shell scripts and shell commands using kernel APIs.
4. Implement and analyze different process scheduling algorithms
5. Implement and analyze different memory management algorithms.
6. Evaluate process management techniques and deadlock handling using simulator.

Descriptions:

Sr. No	**Contents**
1	Explore the internal commands of linux like ls,chdir,mkdir,chown,chmod,chgrp,ps etc
2	Write shell scripts to do the following: ➢ Display top 10 processes in descending order ➢ Display processes with highest memory usage. ➢ Display current logged in user and logname. ➢ Display current shell, home directory, operating system type, current path setting, current working directory. ➢ Display OS version, release number, kernel version. ➢ Illustrate the use of sort, grep, awk, etc.
3	a) Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. Explore wait and waitpid before termination of process. b) Explore the following system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid.
4	Implement basic commands of linux like ls, cp, mv and others using kernel APIs.
5	Write a program to implement any two CPU scheduling algorithms like FCFS, SJF, Round Robin etc.
6	Write a program to implement dynamic partitioning placement algorithms i.e Best Fit, First-Fit, Worst-Fit etc
7	Write a program to implement various page replacement policies.
8	Using the **CPU-OS simulator** analyze and synthesize the following: a. Process Scheduling algorithms. b. Thread creation and synchronization. c. Deadlock prevention and avoidance.

Digital Materials:

1. Download the CPU-OS simulator along with related tutorials from http://www.teach-sim.com
2. http://www.teach-sim.com

Books:

1. Linux Kernel Book, by Remy Card, Eric Dumas, Frank Mevel, Wiley India
2. Unix Concepts and Applications, Sumitabha Das, McGraw Hill.

Term Work:

- Term work should consist of at least 12 experiments and 2-3 assignments on above content.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

- Term Work**:** 25 Marks (Total) = 10 Marks (Experiments)
  + 5 Marks (Mini Project)
  + 5 Marks (Assignments)
  + 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC405: Operating system syllabus.

Lab Code	Lab Name	Credit
CSL405	**Open Source Technology Lab**	**2**

Course Outcomes:

1. To understand basic concepts in python and perl.
2. To explore contents of files, directories and text processing with python
3. To develop program for data structure using built in functions in python.
4. To explore django web framework for developing python based web application.
5. To understand file handling and database handling using perl.
6. To explore basics of two way communication between client and server using python and perl

Prerequisites: Knowledge of some programming language like C, Java

Content:

Sr. No	Module Name	Detailed Content
1	Python basics	Data types in python ,Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes , Objects , Interfaces, Inheritance
2	Advanced Python	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.
3	Data Structure in Python	Link List, Stack, Queues, Dequeues
4	Python Integration Primer	Graphical User interface ,Networking in Python , Python database connectivity, Introduction to Django
5	Basics of Perl	Perl Overview, Variables, Control Statements, Subroutines, Objects, Packages and Modules
6	Perl advanced	Working with Files, Data manipulation, Database Systems, Networking

Text Books

1. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
3. Perl: The Complete Reference. Second Edition. Martin C. Brown, McGraw-Hill
4. Introduction to computing and problem solving using python , E Balagurusamy,McGraw Hill Education

Reference Book

1. Perl Black Book, 2nd Edition: Steven Holzner,Dreamtech Press
2. Learn Python the Hard Way: (3rd Edition) (Zed Shaw's Hard Way Series)
3. Python Projects , Laura Cassell,Alan Gauld,wrox publication

Digital Material:

1. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
2. Beginning Perl, https://www.perl.org/books/beginning-perl/
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested experiments using Python:

1. Exploring basics of python like data types (strings,list,array,dictionaries,set,tuples) and control
2. statements.
3. Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
4. Exploring Files and directories
   a. Python program to append data to existing file and then display the entire fille
   b. Python program to count number of lines, words and characters in a file.
   c. Python program to display file available in current directory
5. Creating GUI with python containing widgets such as labels, textbox,radio,checkboxes and custom dialog boxes.

6. Menu driven program for data structure using built in function for link list, stack and queues.
7. Program to demonstrate CRUD(**create, read, update and delete)** operations on database (SQLite/ MySQL) using python.
8. Creation of simple socket for basic information exchange between server and client.
9. Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).

Suggested experiments using Perl:

10. Exploring various data type , loops and conditional statement in perl. And Creating functions, packages and modules in perl.
11. Program to demonstrate use of objects and classes in perl.
12. Program to demonstrate file handling, data manipulation and use of regular expression for text processing in perl
13. Program to send email and read content of URL.

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 12-14 programs.
2. One mini-project in a group 2-3 student.
3. Two assignments covering whole syllabus.

Term Work (25) = 15 marks (Experiments & Assignments)
+ 10 marks (Mini Project)
+ 05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

AC 11.05.2017
Item No. 4.173

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Mechanical Engineering

Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17.

Co-ordinator, Faculty of Technology Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming sessions, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Mechanical Engineering. The Program Educational Objectives finalized for the undergraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for
B.E. in Mechanical Engineering
University of Mumbai
(With Effect from 2017-2018)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract**	**Theory**	**Pract**	**Total**
MEC301	Applied Mathematics III**	04	--	04	--	04
MEC302	Thermodynamics*	04	--	04	--	04
MEC303	Strength of Materials*	04	--	04	--	04
MEC304	Production Process I*	04	--	04	--	04
MEC305	Material Technology*	03	--	03	--	03
MEL301	Computer Aided Machine Drawing*	--	2[$]+4	--	03	03
MEL302	Strength of Material*	--	02	--	01	01
MEL303	Material Technology*	--	02	--	01	01
MEL304	Machine Shop Practice I*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			**End Sem Exam**	**Exam Duration (Hrs)**	**Term Work**	**Pract/ Oral**	**Total**
		Test1	**Test 2**	**Avg**					
MEC301	Applied Mathematics III**	20	20	20	80	03	--	--	100
MEC302	Thermodynamics*	20	20	20	80	03	--	--	100
MEC303	Strength of Materials*	20	20	20	80	03	--	--	100
MEC304	Production Process I*	20	20	20	80	03	--	--	100
MEC305	Material Technology*	20	20	20	80	03	--	--	100
MEL301	Computer Aided Machine Drawing*	--	--	--	--	--	50	50	100
MEL302	Strength of Material*	--	--	--	--	--	25	25	50
MEL303	Material Technology*	--	--	--	--	--	25	--	25
MEL304	Machine Shop Practice I*	--	--	--	--	--	50	--	50
Total				**100**	**400**		**150**	**75**	**725**

*** Common with Automobile Engineering**

**** Common with Automobile Engineering, Production Engineering and Civil Engineering**

[$] **Theory for entire class to be conducted**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC401	Applied Mathematics IV**	04	--	04	--	04
MEC402	Fluid Mechanics*	04	--	04	--	04
MEC403	Industrial Electronics*	03	--	03	--	03
MEC404	Production Process II*	04	--	04	--	04
MEC405	Kinematics of Machinery*	04	--	04	--	04
MEL401	Data Base and Information Retrieval*	--	2[$]+2	--	02	02
MEL402	Fluid Mechanics*	--	02	--	01	01
MEL403	Industrial Electronics*	--	02	--	01	01
MEL404	Kinematics of Machinery*	--	02	--	01	01
MEL405	Machine Shop Practice II*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC401	Applied Mathematics IV**	20	20	20	80	03	--	--	100
MEC402	Fluid Mechanics*	20	20	20	80	03	--	--	100
MEC403	Industrial Electronics*	20	20	20	80	03	--	--	100
MEC404	Production Process II*	20	20	20	80	03	--	--	100
MEC405	Kinematics of Machinery*	20	20	20	80	03	--	--	100
MEL401	Data Base and Information Retrieval*	--	--	--	--	--	50	50	100
MEL402	Fluid Mechanics*	--	--	--	--	--	25	25	50
MEL403	Industrial Electronics*	--	--	--	--	--	25	25	50
MEL404	Kinematics of Machinery*	--	--	--	--	--	25	--	25
MEL405	Machine Shop Practice II*	--	--	--	--	--	50	50	100
Total				**100**	**400**		**175**	**150**	**825**

*** Common with Automobile Engineering**

**** Common with Automobile Engineering, Production Engineering and Civil Engineering**

[$] Theory for entire class to be conducted

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract**	**Theory**	**Pract**	**Total**
MEC501	Internal Combustion Engines*	04	--	04	--	04
MEC502	Mechanical Measurements and Control*	04	--	04	--	04
MEC503	Heat Transfer*	04	--	04	--	04
MEC504	Dynamics of Machinery	04	--	04	--	04
MEDLO 501X	Department Level Optional Course I	04	--	04	--	04
MEL501	Internal Combustion Engines	--	02	--	01	01
MEL502	Mechanical Measurements and Control	--	02	--	01	01
MEL503	Heat Transfer	--	02	--	01	01
MEL504	Dynamics of Machinery	--	02	--	01	01
MEL505	Manufacturing Sciences Lab	--	02	--	01	01
MEL506	Business Communication and Ethics	--	02[$]+02	--	02	02
Total		**20**	**14**	**20**	**07**	**27**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (Hrs)**			
		Test1	**Test 2**	**Avg**					
MEC501	Internal Combustion Engines	20	20	20	80	03	--	--	100
MEC502	Mechanical Measurements and Control	20	20	20	80	03	--	--	100
MEC503	Heat Transfer	20	20	20	80	03	--	--	100
MEC504	Dynamics of Machinery	20	20	20	80	03	--	--	100
MEDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
MEL501	Internal Combustion Engines	--	--	--	--	--	25	25	50
MEL502	Mechanical Measurements and Control	--	--	--	--	--	25	25	50
MEL503	Heat Transfer	--	--	--	--	--	25	25	50
MEL504	Dynamics of Machinery	--	--	--	--	--	25	25	50
MEL505	Manufacturing Sciences Lab	--	--	--	--	--	25	--	25
MEL506	Business Communication and Ethics	--	--	--	--	--	50	--	50
Total				**100**	**400**		**175**	**100**	**775**

[$] Theory classes shall be conducted for entire class

Course Code	Department Level Elective Course I
MEDLO5011	Press Tool Design
MEDLO5012	Machining Sciences and Tool Design
MEDLO5013	Design of Jigs and Fixtures

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC601	Metrology and Quality engineering	04	--	04	--	04
MEC602	Machine Design I	04	--	04	--	04
MEC603	Finite Element analysis	04	--	04	--	04
MEC604	Refrigeration and Air Conditioning	04	--	04	--	04
MEDLO 602X	Department Level Optional Course II	04	--	04	--	04
MEL601	Metrology and Quality Engineering	--	02	--	01	01
MEL602	Machine Design I	--	02	--	01	01
MEL603	Finite Element Analysis	--	02	--	01	01
MEL604	Refrigeration and Air Conditioning	--	02	--	01	01
MEL605	Mechatronics Lab	--	02	--	01	01
Total		**20**	**10**	**20**	**05**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC601	Metrology and Quality engineering	20	20	20	80	03	--	--	100
MEC602	Machine Design I	20	20	20	80	03	--	--	100
MEC603	Finite Element Analysis	20	20	20	80	03	--	--	100
MEC604	Refrigeration and Air Conditioning	20	20	20	80	03	--	--	100
MEDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100
MEL601	Metrology and Quality engineering	--	--	--	--	--	25	25	50
MEL602	Machine Design I	--	--	--	--	--	25	--	25
MEL603	Finite Element analysis	--	--	--	--	--	25	25	50
MEL604	Refrigeration and Air Conditioning	--	--	--	--	--	25	25	50
MEL605	Mechatronics Lab	--	--	--	--	--	25	25	50
Total				**100**	**400**		**125**	**100**	**725**

Course Code	Department Level Optional Course II
MEDLO6021	Mechatronics
MEDLO6022	Robotics
MEDLO6023	Industrial Automation

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC701	Machine Design II	04	--	04	--	04
MEC702	CAD/CAM/CAE	04	--	04	--	04
MEC703	Production Planning and Control	04	--	04	--	04
MEDLO 703X	Department Level Optional Course III	04	--	04	--	04
ILO701X	Institute Level Optional Course I#	03	--	03	--	03
MEL701	Machine Design II	--	02	--	01	01
MEL702	CAD/CAM/CAE	--	02	--	01	01
MEL703	Production Planning and Control	--	02	--	01	01
MEL704	Project I	--	06	--	03	03
Total		**19**	**12**	**19**	**06**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC701	Machine Design II	20	20	20	80	03	--	--	100
MEC702	CAD/CAM/CAE	20	20	20	80	03	--	--	100
MEC703	Production Planning and Control	20	20	20	80	03	--	--	100
MEDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I#	20	20	20	80	03	--	--	100
MEL701	Machine Design II	--	--	--	--	--	25	25	50
MEL702	CAD/CAM/CAE	--	--	--	--	--	25	25	50
MEL703	Production Planning and Control	--	--	--	--	--	25	25	50
MEP701	Project I	--	--	--	--	--	50	--	50
Total				**100**	**400**		**125**	**75**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
MEDLO7031	Mechanical Vibrations	ILO7011	Product Lifecycle Management
MEDLO7032	Automobile Engineering	ILO7012	Reliability Engineering
MEDLO7033	Pumps, Compressors and Fans	ILO7013	Management Information System
MEDLO7034	Computational Fluid Dynamics	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

# Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract**	**Theory**	**Pract**	**Total**
MEC801	Design of Mechanical Systems	04	--	04	--	04
MEC802	Industrial Engineering and Management	04	--	04	--	04
MEC803	Power Engineering	04	--	04	--	04
MEDLO 804X	Department Level Optional Course IV	04	--	04	--	04
ILO802X	Institute Level Optional Course II#	03	--	03	--	03
MEL801	Design of Mechanical Systems	--	02	--	01	01
MEL802	Power Engineering	--	02	--	01	01
MEP801	Project II	--	12	--	06	06
Total		**19**	**16**	**19**	**08**	**27**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (Hrs)**			
		Test1	**Test 2**	**Avg**					
MEC801	Design of Mechanical Systems	20	20	20	80	03	--	--	100
MEC802	Industrial Engineering and Management	20	20	20	80	03	--	--	100
MEC803	Power Engineering	20	20	20	80	03	--	--	100
MEDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II#	20	20	20	80	03	--	--	100
MEL801	Design of Mechanical Systems	--	--	--	--	--	25	25	50
MEL802	Power Engineering	--	--	--	--	--	25	25	50
MEL803	Project II	--	--	--	--	--	50	100	150
Total				**100**	**400**		**100**	**150**	**750**

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
MEDLO8041	Power Plant Engineering	ILO8021	Project Management
MEDLO8042	Rapid Prototyping	ILO8022	Finance Management
MEDLO8043	Renewable Energy Systems	ILO8023	Entrepreneurship Development and Management
MEDLO8044	Energy Management in Utility Systems	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

# Common with all branches

Course Code	Course Name	Credits
MEC301	**Applied Mathematics III****	**04**

Objectives

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyse engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex variables.

Outcomes: Learner will be able to…

1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

Module	Detailed Contents	Hrs
1	**Laplace Transform** 1.1 Function of bounded variation, Laplace Transform of standard functions such as 1, $t^n, e^{at}, \sin at, \cos at, \sinh at, \cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	**12**
2	**Complex variables:** 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions fo $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories **2.3** Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	**08**
3	**Complex Integration:** 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x)\, dx$	**08**
4	**Fourier Series:** 4.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period $2\pi \ \ and \ \ 2l$	**10**

	4.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parsvel's identities (without proof) 4.3 Complex form of Fourier series	
5	**Partial Differential Equations:** 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	**09**
6	**Correlation and curve fitting** 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Course Code	Course Name	Credits
MEC302	**Thermodynamics***	**04**

Objectives

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize application of the concepts of thermodynamics in vapour power, gas power cycles

Outcomes: Learner will be able to…

1. Demonstrate application of the laws of thermodynamics to wide range of systems.
2. Write steady flow energy equation for various flow and non-flow thermodynamic systems
3. Compute heat and work interactions in thermodynamics systems
4. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
5. Use steam table and mollier chart to compute thermodynamics interactions
6. Compute efficiencies of heat engines, power cycles etc.

Module	Detailed Contents	Hrs
01	**Basic Concepts & definitions:** Thermodynamics and its importance, Macroscopic and Microscopic view point, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Control Volume approach and Systems approach, Equilibrium – Thermal ,Chemical, Mechanical and thermodynamic, Pure Substance, Property – Intensive and Extensive, State, Path, Process and Cycle. Point Function and Path Function, Quasi Static Process and processes like Isobaric, Isochoric, Isothermal, Polytropic Process, Temperature and different scales, Zeroth Law of Thermodynamics, Energy, sources of energy; forms of energy, Energy transfer by work and forms of work ; free Expansion, Energy transfer by heat ; Adiabatic Process, Equations of state, Ideal gas Equation-; Specific gas constant and Universal Gas Constant	08
02	**First Law of Thermodynamics:** Relation between Heat and Work- Joules Constant, First law of thermodynamics for a cyclic process, First law of thermodynamics for a closed system undergoing a process, Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind, Application of first law of thermodynamics to closed system or Non flow Process, Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process – Joules Thompson Coefficient and its significance	07
03	**Second Law of Thermodynamics:** Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale **Entropy:** Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy	07
04	**Thermodynamic Relations:** Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius-Clapeyron Equation **Availability:**	10

	High grade and Low Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle, Decrease of Available Energy When heat is transferred through a finite temperature Difference, Second Law efficiency **Properties of Pure Substance:** Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart with suitable examples.	
05	**Compressors:** Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numerical), Theoretical and actual indicator diagram for multi stage compressors Rotary Air Compressors- Classification, Difference between compressors and blowers, Working and constructional details of roots blower, Screw type and vane type compressors	08
06	**Vapour Power cycle:** Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle. **Gas Power cycles:** Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Brayton Cycle, Sterling Cycle and Ericsson Cycle and Lenoir cycle and Atkinson cycle	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles,7th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers Engineering
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 5th edition, TMH
5. Thermodynamics by Onkar Singh, New Age International
6. Thermodynamics by C P Arora, TMH
7. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
8. Fundamentals of Thermodynamics by Moran & Shapiro
9. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., JohnWiley & Sons
10. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
11. Thermodynamics by J P Holman, McGraw-Hill & Co

Course Code	Course Name	Credits
MEC303	**Strength of Materials***	**04**

* Course common to Mechanical and Automobile Engineering

Objectives:

1. To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.
3. To study the effects of component dimensions, materials and shapes on stresses and deformations

Outcomes: Learner will be able to…

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the stresses induced in basic mechanical components.
4. Estimate the strain energy in mechanical elements.
5. Analyse the deflection in beams.
6. Analyse buckling and bending phenomenon in columns, struts and beams.

Module	Detailed Contents	Hrs
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, , Parallel Axis theorem, Polar moment of Inertia. **Stresses and Strains:** Definition – Stress, Strain, Hooke's law, elastic limit, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr's circle. **Elastic Constants:** Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk Modulus, yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading, deformation of tapering members, deformation due to self –weight, bars of varying sections, composite sections, thermal stress and strain.	12
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	08
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Flitched beams. **Direct and Bending Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	08
4	**Torsion:** Torsion of circular shafts- solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. **Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.	08

5	**Deflection of Beams:** Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings **Thin Cylindrical and Spherical Shells:** Cylinders and Spheres due to internal pressure, Cylindrical shell with hemi spherical ends	08
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2. Strength of Materials by Ryder, Macmillan
3. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6th Ed, 2009
4. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
5. Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi
6. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
7. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
8. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
9. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
10. Introduction to Solid Mechanics by Shames, PHI
11. Strength of Materials by Nag and Chandra, Wiley India
12. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
13. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

Course Code	Course Name	Credits
MEC304	**Production Process***	**04**

Objectives

1. To study basic production processes.
2. To study how to select appropriate production processes for a specific application.
3. To study machine tools

Outcomes: Learner will be able to…

1. Demonstrate understanding of casting process
2. Illustrate principles of forming processes
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Distinguish between the conventional and modern machine tools.

Module	Detailed Contents	Hrs
1	1.1 **Metal casting:** Classification of Production Processes: Examples and field of applications Pattern materials and allowances, Types of pattern, Sand properties, Sand moulding, Machine moulding Gating system :Types of riser, types of gates, solidification Melting- cupola& induction furnaces 1.2 **Special casting processes** : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	**10**
2	2.1 **Joining processes:** Welding: Classification of welding, Oxy-acetylene welding, types of flames, equipment used, welding methods & applications, Arc welding principle and working of metal arc welding, TIG & MIG welding, submerged arc welding, electro-slag welding & stud welding PAM welding. Applications merits & demerits of above welding processes, fluxes used, Thermit welding, Resistance welding, Friction welding, ultrasonic, explosive, LASER, electron beam welding, Welding defects and remedies Soldering and brazing techniques & applications Fastening processes	**10**
3	3.1 **Forming processes:** Principles and process characteristics, Rolling types, Rolling parameters: Draught, spread, elongation, roll pressure, torque, work and power in rolling. Effect of front and back tension on rolling load and capacities, Rolling defects, Thread rolling roll forging, production of seamless tubes, Forging, Extrusion and Wire Drawing processes	**08**
4	4.1 **Moulding with polymers:** Moulding with polymers: Basic concepts related to Injection Moulding, Compression moulding, Transfer moulding, Blow Moulding, Rotational Moulding, Thermoforming and Extrusion. Applications of plastics in Engineering field 4.2 **Moulding with ceramics**: Blow moulding and extrusion of glass.	**06**
5	**Classification, Selection and application of Machine Tools:** 5.1 Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. 5.2 Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes	**10**
6	5.1 **Modern Machine Tools:** CNC machines: Introduction, principles of operation, Types – Vertical machining centres and horizontal machining centres, major elements, functions, applications, controllers, open loop and closed loop systems 5.2 Types of automatic machines, Transfer machines	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Workshop Technology By W. A. J. Chapman part I, II & III
2. A Textbook of Foundry Technology by M. Lal
3. Production Technology by R. C. Patel and C. G. Gupta Vol I, II.
4. Production Technology by Jain & Gupta
5. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R. Schmid, Prentice Hall
6. Production Technology by HMT
7. Elements of Workshop Technology Hazra Chaudhary Vol I, II.
8. Foundry technology by P.L. Jain
9. Production Technology by P.C. Sharma
10. Manufacturing processes by P. N. Rao, Vol. 1 and 2

Course Code	Course Name	Credits
MEC305	**Material Technology***	**03**

Objectives

1. To study basic engineering materials, their structure-property-performance
2. To study strengthening processes including heat treatment processes in order to enhance properties.
3. To study new materials and their applications

Outcomes: Learner will be able to…

1. Identify various crystal imperfections, deformation mechanisms, and strengthening mechanisms
2. Demonstrate understanding of various failure mechanisms of materials.
3. Interpret Iron-Iron carbide phase diagram, and different phases in microstructures of materials at different conditions.
4. Select appropriate heat treatment process for specific applications.
5. Identify effect of alloying elements on properties of steels
6. Illustrate basics of composite materials, Nano- materials and smart materials.

Module	Detailed Contents	Hrs
1	**1.1 Classification of Materials:** Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples **1.2 Lattice Imperfections:** Definition, classification and significance of Imperfections Point defects: vacancy, interstitial and impurity atom defects, Their formation and effects, Dislocation - Edge and screw dislocations Burger's vector, Motion of dislocations and their significance, Surface defects - Grain boundary, sub-angle grain boundary and stacking faults, their significance, Generation of dislocation, Frank Reed source, conditions of multiplication and significance. **1.3 Deformation:** Definition, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping, Critical Resolved shear stress, Deformation in single crystal and polycrystalline materials, Slip systems and deformability of FCC, BCC and HCP lattice systems. **1.4 Strain Hardening:** Definition importance of strain hardening, Dislocation theory of strain hardening, Effect of strain hardening on engineering behaviour of materials, Recrystallization Annealing: stages of recrystallization annealing and factors affecting it	**08**
2	**Failure mechanisms:** **1.1 Fracture:** Definition and types of facture, Brittle fracture: Griffith's theory of fracture, Orowan's modification, Dislocation theory of fracture, Critical stress and crack propagation velocity for brittle fracture, Ductile fracture: Notch effect on fracture, Fracture toughness, Ductility transition, Definition and significance **1.2 Fatigue Failure:** Definition of fatigue and significance of cyclic stress, Mechanism of fatigue and theories of fatigue failure, Fatigue testing, Test data presentation and statistical evolution, S-N Curve and its interpretation, Influence of important factors on fatigue, Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue. **1.3 Creep:** Definition and significance of creep, Effect of temperature and creep on mechanical behaviours of materials, Creep testing and data presentation and analysis, Mechanism and types of creep, Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications, Creep Resistant materials	**08**
3	**3.1 Theory of Alloys& Alloys Diagrams :** Significance of alloying, Definition, Classification and properties of different types of alloys, Solidification of pure metal, Different types of phase diagrams (Isomorphous, Eutectic,	**08**

	Peritectic, Eutectoid, Peritectoid) and their analysis, Importance of Iron as engineering material, Allotropic forms of Iron, Influence of carbon in Iron- Carbon alloying Iron-Iron carbide diagram and its analysis, TTT diagram, CCT diagram Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons, their microstructures, properties and applications	
4	**4.1 Heat treatment Process:** Technology of heat treatment, Classification of heat treatment process, Annealing- Principle process, properties and applications of full annealing, Diffusion annealing, process annealing and Cyclic annealing, Normalizing, Hardening heat treatment, Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process, Surface hardening: Hardening and surface Hardening methods. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	**06**
5	**5.1 Effect of Alloying Elements in Steels**: Limitation of plain carbon steels, Significance of alloying elements,Effects of major and minor constituents, Effect of alloying elements on phase transformation Classification of tool steels and metallurgy of tool steels and stainless steel	**04**
6	**Introduction to New materials:** **6.1** Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications **6.2** Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites **6.3** An overview to Smart materials (e.g.: Rheological fluids)	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R.Balasubramaniam, Wiley India (P) Ltd
2. Material Science and Metallurgy by V.D. Kodgire, Everest Publishing House
3. Mechanical Behaviour of Materials by Courtney, McGraw Hill International New Delhi
4. Introduction of Engineering Materials, by B.K. Agrawal, McGraw Hill Pub. Co. ltd
5. Mechanical Metallurgy by G.E. Dieter, McGraw Hill International New Delhi
6. A text book of Metallurgy by A.R.Bailey, Macmillan & Co. Ltd., London
7. The Structure and Properties of Engineering Alloys by W.F. Smith, McGraw hill Int.
8. Engineering Physical Metallurgy, by Y. Lakhtin, Mir Publishers, Moscow
9. Introduction to Physical Metallurgy by SydneyAvner, McGraw Hill
10. Metallurgy for Engineers by E.C. Rollason - ELBS SOC and Edward Arnold, London

Course Code	Course Name	Credits
MEL301	**Computer Aided Machine Drawing***	**03**

Objectives:

1. To familiarise conversion of an object into a drawing
2. To study conventional representation of various machining and mechanical details as per IS
3. To become conversant with 2-D and 3-D drafting

Outcomes: Learner will be able to…

1. Visualize and prepare detail drawing of a given object.
2. Read and interpret the drawing
3. Draw details and assembly of different mechanical systems.
4. Convert detailed drawing into assembly drawing using modelling software
5. Convert assembly drawing into detailed drawing using modelling software
6. Prepare detailed drawing of any given physical object/machine element with actual measurements

Module	**Detailed Contents**	Theory	Practical
1	**1.1 Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc)	02	04
	1.2 Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components	01	--
	1.3 Solid Geometry: Intersection of surfaces and interpenetration of solids- Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views	04	--
2	**2.1 Geometric Dimensioning and Tolerancing (GD&T)** : Dimensioning with tolerances indicating various types of fits,	02	--
	2.2 Details and assembly drawing: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards,	02	--
	2.3 Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa,		
	2.4 Preparation of details and assembly drawings of *any three* from: Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures	02	08
	2.5 Cotter, Knuckle joint, Keys: keys-sunk, parallel woodruff, saddle, feather etc.	01	--
	2.6 Couplings: simple, muff, flanged Protected flange coupling, Oldham’s coupling, Universal coupling	02	06
3	**3.1 Preparation of details and assembly drawings of Bearings:** Simple, solid, Bushed bearing, I.S. conventional representation of ball and roller bearing, Pedestal bearing, footstep bearing	02	06
4	**4.1 Preparation of details and assembly drawings of pulleys, Pipe joints:** Classification of Pulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	06
	4.3 Pipe joints*(any two)*: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	--	06
5	**5.2 Preparation of details and assembly drawings of Valves, I.C. Engine parts:** Types of Valves, introduction to I.C. Engine	02	--
	5.3 Preparation of details and assembly drawings*(any three):* Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburettor, Fuel pump, injector, and Spark plug	--	08

6	**6.1 Reverse Engineering of a physical model**: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	02	06

Assessment:

Term work

A. Minimum two questions from theory part of each module should be solved as a home work in A-3 size sketch book.

B. A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module. Problems from practical parts of each module should be solved using any standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works, Inventor etc.

The distribution of marks for Term work shall be as follows:

Home work sketch book	20 marks
Printouts/Plots	20 marks
Attendance	10 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is **three hours**, based on Part-B of the Term work, and should contain two sessions as follows:

Session-I: Preparation of 3-D models of parts, assembling parts and preparing views of assembly from given 2-D detailed drawing.

Session-II: Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.

Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.

2. Questions provided for practical examination should contain minimum five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:

- **Session-I** …… ….20 marks
- **Session-II** …… …20 marks
- **Oral** …… ……….10 marks

4. Evaluation of practical examination to be done based on the printout of students work

5. Students work along with evaluation report to be preserved till the next examination

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L. Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M. B. Shah
5. A text book of Machine Drawing by R. B. Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I.Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Course Code	Course Name	Credits
MEL302	**Strength of Materials***	**01**

Objectives:

1. To familiarise material behaviour under different loading conditions
2. To acquaint with surface hardness measurement method
3. To familiarise with impact test methods for different materials

Outcomes: Learner will be able to…

1. Analyse the stress - strain behaviour of materials
2. Measure ultimate tensile/compression strength of material
3. Measure torsional strength of material
4. Perform impact test using Izod and Charpy method
5. Measure the hardness of materials.
6. Perform flexural test with central and three point loading conditions

a) List of Experiments (Minimum Eight)

Module	Detailed Contents	Laboratory Sessions
1	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2 Hrs
2	Bending test on UTM	2 Hrs
3	Torsion test on mild steel bar / cast iron bar	2 Hrs
4	Impact test on metal specimen (Izod test)	2 Hrs
5	Impact test on metal specimen (Charpy test)	2 Hrs
6	Hardness test on metals - Brinell Hardness Number	2 Hrs
7	Hardness test on metals - Rockwell Hardness Number	2 Hrs
8	Flexural test on beam (central loading)	2 Hrs
9	Flexural test on beam (three point loading)	2 Hrs

b) Assignments: Atleast one problem on each of the following topics:

1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Strain energy and deflection.
5. Torsion, Columns and struts

Note: Preferably, the assignments shall be based on live problems.**Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term Work: Including Part a and b both

Distribution of marks for Term Work shall be as follows:

Part a	:	15marks.
Part b	:	05 Marks
Attendance	:	05 marks.

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
MEL303	**Materials Technology***	**03**

Objectives:

1. To familiarise with use of optical laboratory microscope
2. To acquaint with microstructures of ferrous (steel and cast iron) metals
3. To familiarise with microstructures of steel under different heat treated conditions
4. To study hardenability, fatigue test for fatigue strength and corrosion rate test

Outcomes: Learner will be able to…

1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography)
2. Interpret different phases present in different plain carbon steels and cast irons.
3. Perform different heat treatment processes for a steel and observe microstructures in these conditions
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel
5. Determine hardenability of steel using Jominy end Quench test
6. Determine S-N curve by Fatigue Test.

Sr No	Details
1	Study of metallurgical microscope
2	Metallographic sample preparation and etching
3	Microstructures of plain carbon steels
4	Microstructures of cast irons
5	Annealing, Normalizing and Hardening of medium carbon steel and observation of microstructures
6	Study of tempering characteristics of hardened steel
7	Determination of hardenability of steel using Jominy end Quench Test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

Assignments: Assignment on following topics

1. Crystal imperfections-deformation-strengthening mechanisms
2. Fracture-failure of metals
3. Iron –Iron carbide phase diagram/TTT diagram/CCT diagram.
4. Heat treatment processes
5. Alloy steels (e. g. alloy steels, tool steels)
6. New materials

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments**

Assessment:

Term Work: Including Laboratory Work and Assignments both

Distribution of marks for Term Work shall be as follows:

Laboratory work	15 marks
Assignments	05 Marks
Attendance	05 marks

Course Code	Course Name	Credits
MEL304	**Machine Shop Practice I***	**02**

Objectives:

1. To study basic machining processes.
2. To familiarise various machining operations and machine protocols

Outcomes: Learner will be able to…

1. Operate various machines like lathe, shaper etc.
2. Perform plain turning, taper turning, and screw cutting etc. on lathe machine.
3. Perform machining operations on shaper.
4. Demonstrate metal joining process like compressive welding.
5. Perform forging operations
6. Perform shaping operations

Module	Details	Hrs
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Taper Turning One job on Precision Turning, Taper Turning and Screw Cutting	**18**
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	**12**
3	Introduction to various forging tools Two jobs on Forging of Cutting Tools used on Lathe Machine	**12**
4	One simple exercise on Welding, Preparation of a component using Compressive Welding Joint	**6**

Assessment:

Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book	…….**40** marks
Attendance	…….**10** marks

Course Code	Course Name	Credits
MEC401	**Applied Mathematics IV****	**04**

Objectives:

1. To inculcate an ability to relate engineering problems to mathematical context
2. To provide a solid foundation in mathematical fundamentals required to solve engineering problem
3. To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
4. To prepare students for competitive exams

Outcomes: Learner will be able to…

1. Solve the system of linear equations using matrix algebra with its specific rules
2. Demonstrate basics of vector calculus
3. Apply the concept of probability distribution and sampling theory to engineering problems
4. Apply principles of vector calculus to the analysis of engineering problems
5. Identify, formulate and solve engineering problems
6. Illustrate basic theory of correlations and regression

Module	Details	Hrs
1	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) . Similarity of matrices. Functions of a square matrix	**08**
2	**Matrices:** 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors **Vector calculus** 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	**09**
3	**Vector calculus:** 3.1 Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem) **Linear Programming problems** 3.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	**09**
4	**Linear Programming problems Probability Distributions:** 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. **Probability Distributions** 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	**09**

5	**Sampling theory:** 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical 5.2. region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples 5.3. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. **5.4.** Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	**09**
6	**Sampling theory and ANOVA** 6.1. Chi-square test, Test for the Goodness of fit , Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Course Code	Course Name	Credits
MEC402	**Fluid Mechanics***	**04**

Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.

Outcomes: Learner will be able to…

1. Define properties of fluids and classification of fluids
2. Evaluate hydrostatic forces on various surfaces and predict stability of floating bodies
3. Formulate and solve equations of the control volume for fluid flow systems
4. Apply Bernoulli's equation to various flow measuring devices
5. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces
6. Apply fundamentals of compressible fluid flows to relevant systems

Module	**Detailed Contents**	**Hrs**
1	1.1Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids 1.2Fluid Statics: Definition of body and surface forces, Pascal's law, Basic hydrostatic equation, Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle	**06**
2	2 **Fluid Kinematics:** 2.1 Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two and three dimensional flows; Definition of control volume and control surface, Understanding of differential and integral methods of analysis 2.2 Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates, rotational and irrotational flows; Definition and equations for source, sink, irrotational vortex, circulation	**06**
3	3 **Fluid Dynamics:** 3.1 Integral equations for the control volume: Reynold's Transport theorem, equations for conservation of mass, energy and momentum, Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice and nozzle meters. 3.2 Differential equations for the control volume: Mass conservation in 2 and 3 dimension in rectangular, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation; Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes (Couette flow and plane Poiseuille flow)	**12**
4	4 **Real fluid flows:** 4.1 Definition of Reynold's number, Laminar flow through a pipe (Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows and theories of turbulence-Statistical theory, Eddy viscosity theory and Prandtl mixing length theory; velocity profiles for turbulent flows-universal velocity profile, 1/7th power law; Velocity profiles for smooth and rough pipes 4.2 Darcy's equation for head loss in pipe (no derivation),Moody's diagram, pipes in series and parallel, major and minor losses in pipes	**08**
5	5 **Boundary Layer Flows:** 5.1Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer,	**08**

	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies 5.2Aerofoil theory: Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag	
6	**6 Compressible Fluid flow:** 6.1 Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity , momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio 6.2 Normal shocks, basic equations of normal shock, change of properties across normal shock	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press
3. Introduction to Fluid Mechanics by Fox and McDonald
4. Fluid Mechanics by R K Bansal
5. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
6. Fluid Mechanics by K. L. Kumar
7. Introduction to Fluid Mechanics by James A. Fay
8. Fluid Mechanics by B. M. Massey
9. Mechanics of Fluids by Irving Shames
10. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd

Course Code	Course Name	Credits
MEC 403	Industrial Electronics*	3

Objectives

1 To study power electronic switches and circuits and their applications
2 To familiarise Op amp and digital circuits and their applications
3 To acquaint with basics of microprocessor and microcontroller
4 To study structure, working and characteristics of different types of industrial electric motors and their
5 selection for a particular application

Outcomes: Learner will be able to…

1 Illustrate construction, working principles and applications of power electronic switches
2 Identify rectifiers and inverters for dc and ac motor speed control
3 Develop circuits using OPAMP and timer IC555
4 Identify digital circuits for industrial applications
5 Illustrate the knowledge of basic functioning of microcontroller
6 Analyse speed-torque characteristics of electrical machines for speed control

Module	Detailed Contents	Hrs.
1	**Semiconductor Devices:** Diodes: Principles V-I characteristics and Application of: rectifier diode, zener diode, LED, photodiode, SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn-off thyristor (GTO). Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit. Characteristics and principle of Power BJT, power MOSFET, IGBT, comparison of devices, MOSFET/IGBT Gate driver circuit Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	08
2	**Phase controlled rectifiers and Bridge inverters**: Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Derivation of output voltage Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	07
3	**Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, Optical Isolation amplifier; 555 timer-Operating modes: monostable, astable multivibrator	04
4	**Digital logic and logic families:** Digital signals, combinational and sequential logic circuits, clock signals, Boolean algebra and logic gates. Integrated circuits and logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL logic family CMOS Logic family, comparison with TTL family Flip flops: Set Reset(SR),Trigger(T), clocked F/Fs; Registers, decoders and encoders, Multiplexer and Demultiplexer, applications	04
5	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller	08

	MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	
6	**Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Course Code	Course Name	Credits
MEC404	**Production Process II***	**04**

Objectives

1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To Acquaint tobasic principles of design of jigs and fixtures
3. To give exposure to Non-traditional machining operations.
4. To acquaint with fundamentals of metal cutting and tool engineering

Outcomes: Learner will be able to…

1. Demonstrate understanding of metal cutting principles and mechanism
2. Identify cutting tool geometry of single point and multipoint cutting tool
3. Demonstrate various concepts of sheet metal forming operations
4. Demonstrate concepts and use of jigs and fixtures
5. Illustrate various non-traditional machining techniques
6. Illustrate concepts and applications of additive manufacturing

Module	Details	Hrs
1	**Metal Cutting:** 1.1 Features of machining processes, concept of speed and cutting, mechanism of chip formation, concept of shear plane, chip reduction coefficient force analysis, Merchants circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles, Merchants theory-original and modified, effect of various parameters on cutting forces 1.2 Different types of dynamometers and their operations, Tool life definition, mechanism of tool wear and measurement, preliminary and ultimate feature, factors influencing tool life such as speed, feed, depth of cut, tool material, cutting fluids etc., Machinability, factors affecting surface finish	**16**
2.	**Tool Engineering**: 2.1 Cutting Tool geometry and definition of principles tool angles of single point cutting tools, Types of milling cutters and their geometry, Geometry of drill, broach 2.2 Specification & Selection of grinding wheel, dressing & truing and balancing of grinding wheels	**06**
3.	**Sheet Metal Forming**: 3.1 Sheet metal operations, Classification of presses, Types of Dies:, compound, combination, progressive, bending, forming and drawing dies, scrap strip layout, centre of pressure, selection of die sets, stock guides, strippers	**06**
4.	**Jigs and Fixtures**: 4.1 Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture	**06**
5.	**Non-traditional Machining:** 5.1 Ultrasonic Machining (USM), Abrasive Jet Machining (AJM),Water Jet Machining, Electrochemical Machining (ECM),Chemical Machining (CHM)Electrical Discharge Machining (EDM),Plasma Arc Machining (PAM),Laser Beam Machining (LBM),Electron Beam Machining (EBM)	**06**

6.	**Additive Manufacturing:** 6.1 Historical Development , Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping ,Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining, Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD, Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems 6.2 New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition 6.3 Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP).	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Tool Design by Donaldson
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R Schmid, Prentice Hall
5. Fundamentals of Tool Design by ASTME
6. Metal cutting Theory & Cutting Tool Designing by V. Arshinov, G Alekseev
7. Principle of Metal cutting by Sen & Bhattacharya
8. Manufacturing science by Ghosh and Mallick
9. Production Engg by P.C.Sharma
10. Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, , 2nd Edition, Springer 2015

Course Code	Course Name	Credits
MEC405	**Kinematics of Machinery***	**04**

Objectives:

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarise with various basic mechanisms and inversions
3. To study basics of power transmission

Outcomes: Learner will be able to…

1. Define various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Draw Cam profile for the specific follower motion
5. Analyse forces in various gears
6. Select appropriate power transmission for specific application

Module	Details	Hrs.
1	**1.1 Kinetics of Rigid Bodies:** Mass M.I. about centroidal axis and about any other axis, Radius of Gyration, D'Alembert's Principle of bodies under rotational motion about a fixed axis and plane motion, Application of motion of bars, cylinders and spheres only Kinetics of Rigid bodies: Work and Energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work Energy Principle and Conservation of energy **1.2 Basic Kinematics:** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	**10**
2	**2.1 Special Mechanisms:** **Straight line generating mechanisms:** Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's,Grasshopper mechanism, Tchebicheff's mechanisms **Offset slider crank mechanisms -** Pantograph, Hook-joint (single and double). **Steering Gear Mechanism -** Ackerman, Davis steering gears	**06**
3	**3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links):** Velocity analysis by instantaneous center of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) Analysis extended to find rubbing velocities at joints, mechanical advantage (Graphical approach) Velocity analysis of low degree complexity mechanism (Graphical approach), Auxiliary point method **3.2 Velocity and Acceleration Analysis of Mechanism:** Velocity and Acceleration- analysis by relative method (mechanism up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach)	**10**
4	**4.1 Cam Mechanism:** Cam and its Classification, Followers and its Classification, Motion analysis and plotting of displacement - time, velocity-time, acceleration-time, jerk-time graphs for uniform velocity, UARM, SHM, and Cycloid motions (combined motions during one stroke excluded), Motion analysis of simple cams - R-R cam, D-R-R and D-R-D-R Cam operating radial translating follower, Pressure angle	**06**

5	**5.1 Belts, Chains and Brakes**: **Belts**: Introduction, types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission **Chains:** types of chains, chordal action, variation in velocity ratio, length of chain **Brakes:** Introduction, types and working principles, Introduction to braking of vehicles	**06**
6	**6.1 Gears and Gear Trains:** **Gears-** Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik
2. Theory of Machines and Mechanism by Uicker Jr, Garden Pennock & J.F. Shigley, OXFORD University Press
3. Theory of Machines by P L Ballaney
4. Theory of Machines by S S Ratan
5. Kinematics of Machines by R T Hinckle, Prentice Hall Inc
6. Kinematics by V M Fairs, McGraw Hill
7. Mechanism Design: Analysis and Synthesis Vol I by A. Erdman and G N Sander, Prentice Hall
8. Kinematics and Dynamics of Planer mechanisms by Jeremy Hirsihham, McGraw Hill
9. Theory of Machines by W. G. Green, Bluckie & Sons Ltd

Course Code	Course Name	Credits
MEL401	**Data Base and Information Retrieval***	**02**

Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarise Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

Outcomes: Learner will be able to…

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

Module	Detailed Contents	Hrs.
01	**Introduction to Database Concept:** What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator	02
02	**Entity-Relationship Data Model:** Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	**Rational Model and Algebra:** Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	**Structured Query Language (SQL):** Overview of SQL, Data definition commands, set operations, aggregrate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	**Introduction to Transactions Management and Co-currency:** Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, **Co-currency Control:** Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	**Graphical User Interface:** Murphy’s law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work **Visual Programming:** ***Sharing Data and Code:*** Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, usinf and creating ActiveX components, dynamics data exchange, Object linking and embedding, ***Creating visual software entities:*** Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces	06

Assessment:

Term Work:

Assign minimum two case studies for each student. On their case studies following exercises to be performed

1. Problem Definition and draw ER/EER diagram
2. Design Relational Model
3. Perform DDL operation
4. Perform DML and DCL operations
5. Design Forms using Visual programming
6. Retrieve the information through GUI.

Distribution of Term work Marks

Laboratory work	40 Marks
Attendance	10 Marks

End Semester Practical/Oral Examination:

1. Practical examination of 2 hours duration followed by viva to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks

Practical examination:	40 marks
Viva based on practical examination	10marks

4. Students work along with evaluation report to be preserved till the next examination

Reference Books:

1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Slberchatz, Sudarshan, 6thEdition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program, Deitel and Deitel,3rdEdition, Pearson Education
5. SQL and PL/SQL for Oracle 10g,Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India

Course Code	Course/Subject Name	Credits
MEL402	**Fluid Mechanics***	**1**

Objectives:

1. To study measurement as well as calibration principles
2. To practically verify the concepts learnt in theory course

Outcomes: Learner will be able to…

1. Calibrate different gauges
2. Measure hydrostatic forces
3. Verify the Archimedes Principle
4. Calibrate Venturimeter, Orificemeter and Pitot tube
5. Verify the Bernoulli's Principle
6. Read manometers and maintain them.

(a) List of Experiments: Any 6 experiments to be performed.

Expt no	**Experiment**	**Hrs**
1	Calibration of Pressure Gauges	**2**
2	Measurement of Hydrostatic Pressures	**2**
3	Verification of Archimedes' Principle	**2**
4	Calibration of Venturimeter/ Orificemeter/Nozzlemeter/ Pitot tube	**2**
5	Determine the friction factor for Pipes	**2**
6	Determination of major and minor losses in Pipe systems	**2**
7	Verification of Bernoulli's Equation	**2**
8	Experiment on Laminar flow in pipes	**2**
9	Calculation of Lift and Drag over an aerofoil	**2**
10	Determine the pressure profile over an aerofoil	**2**

(b) Mini Project: A mini project along with a brief report in which a group of students (maximum 4) will design/ fabricate/ assemble a unit or software based simulation to demonstrate any principle in Fluid Mechanics.

Assessment:

Term work Mark distribution will be as follows:

Laboratory work	15 marks
Mini Project	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL403	**Industrial Electronics***	**01**

Objectives

1. To study operational characteristics of various electrical and electronics components
2. To study microcontroller based applications and its programming

Outcomes: Learner will be able to…

1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different basic gates
4. Identify and use digital circuits for industrial applications
5. Built and demonstrate basic parameter measurement using microcontroller
6. Test and Analyse speed-torque characteristics of electrical machines for speed control.

List of Experiment: Minimum six from 1-9 and four from 10-15, in all minimum ten experiments need to be performed

Sr No	Detailed Contents
1	MOSFET / IGBT as a switch
2	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4	Full wave Rectifier using SCR
5	Single phase Bridge inverter with rectifier load
6	OPAMP as integrator
7	555 timer as astable multivibrator
8	Implementing study of gates and Logic Operations like, NOT, AND, OR
9	Realization of basic gates using universal gates
10	Light dimmer circuit using Diac-Triac
11	Speed control of DC motor
12	Speed control of induction motor
13	Simple programs using microcontroller
14	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
15	Microcontroller based speed control for Induction Motor

Learners (in a group) may be encouraged for Project Based Learning. Appropriate Weightage may be given in term work assessment

Assessment:

Distribution of marks for term work

Laboratory work	20 Marks
Attendance	05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks

3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL 404	**Kinematics of Machinery***	**01**

Objectives:

1. To familiarise with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to…

1. Draw velocity diagram by instantaneous center method
2. Draw velocity and acceleration diagrams for four bar mechanism by relative method.
3. Draw velocity and acceleration diagrams for Slider crank mechanism by relative method
4. Draw Cam profile for the specific follower motion
5. Plot displacement-time, velocity-time, acceleration-time cam profiles
6. Develop and build mechanisms to provide specific motion

Term Work: (Comprises a and b)

a) List of Experiments

Sr No	**Details**	**Lab Session**
1	Analysis of velocity of mechanisms by Instantaneous Center of Rotation – 3 to 5 problems	2 Hrs
2	Analysis of velocity of mechanism by Relative method – 3 to 5 problems	4 Hrs
3	Analysis of Velocity & Acceleration of mechanism by Relative method – 3 to 5 problems	4 Hrs
4	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time and layout of cam profiles - 2 to 3 problems	4 Hrs
5	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	6 Hrs

b) Assignments: Minimum two problems on each of the following topics:

- **i)** Brakes
- **ii)** Chains and belts
- **iii)** Gear and gear trains

Distribution of marks for Term Work shall be as follows:

Laboratory work : 15marks.
Assignments : 05 Marks
Attendance : 05 marks.

Course Code	Course/Subject Name	Credits
MEL405	**Machine Shop Practice – II***	**2**

Objectives:

1. To familiarise with basic machining processes.
2. To Acquaint to various machining operations and machine protocols

Outcomes: Learner should be able to ….

1. Operate lathe machine,
2. Perform shaping operations
3. Perform finishing operations on grinding machine
4. Perform milling operations.
5. Perform precision turning
6. Perform drilling and threading operations.

Module	Details	Hrs
1	One composite job consisting minimum four parts employing operations on lathe like precision turning screw cutting, boring etc. This job shall involve use of shaping, milling and grinding operations	48

Term Work:

1. Composite job mentioned above

2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book	……. 40 marks
Attendance	……. 10 marks

End Semester Practical Examination:

Pair of Internal and External Examiner should conduct practical/viva based on contents.
Practical examination will be held for 4 hours.
Job shall consist of minimum four operations such as precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.

Course Code	Course/Subject Name	Credits
MEC501	**Internal Combustion Engines***	**4**

Objectives

1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To acquaint with the various methods for measurement of engine performance
3. To provide insight into the harmful effects of engine pollutants and its control
4. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to…

1. Demonstrate the working of different systems and processes of S.I. engines
2. Demonstrate the working of different systems and processes of C.I. engines
3. Illustrate the working of lubrication, cooling and supercharging systems.
4. Analyse engine performance
5. Illustrate emission norms and emission control
6. Comprehend the different technological advances in engines and alternate fuels

Module	Detailed Contents	Hrs.
01	**Introduction** Classification of I.C. Engines; Parts of I.C. Engine and their materials, Cycle of operation in Four stroke and Two-stroke IC engines and their comparative study; Fuel air cycles and their analysis, Actual working cycle, Valve Timing Diagram. LHR Engines, Homogeneous charge compression Ignition,Rotary engine-Six stroke engine concept	06
02	**S.I. Engines** **Fuel Supply System:** Spark ignition Engine mixture requirements, Fuel-Air ratio, Simple carburettor and auxiliary circuits (excluding mathematical analysis of carburettors) Injection systems: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker **Combustion :** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers	12
03	**Compression Ignition Engines** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	10
04	**Engine lubrication:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers	06

05	**Engine Testing and Performance** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engine Effect of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric efficiencies, Heat balance sheet. **Engine Exhaust Emission and its control** Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	10
06	**Alternative Fuels** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engine, Mathur and Sharma
4. Internal Combustion Engines, Mohanty, Standard Book House
5. Internal Combustion Engine, Gills and Smith
6. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan, TMH
9. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
10. Internal Combustion Engine, S.L. Beohar
11. Internal Combustion Engine, P.M Heldt.
12. Internal Combustion Engines, V.L. Maleeve
13. Internal Combustion Engine, E.F. Oberi.
14. Internal Combustion Engine by Domkundwar

Course Code	Course/Subject Name	Credits
MEC502	**Mechanical Measurement and Control***	**4**

Objectives

1. To impart knowledge of architecture of the measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modelling of the control system
4. To acquaint with control system under different time domain

Outcomes: Learner will be able to…

1. Classify various types of static characteristics and types of errors occurring in the system.
2. Classify and select proper measuring instrument for linear and angular displacement
3. Classify and select proper measuring instrument for pressure and temperature measurement
4. Design mathematical model of system/process for standard input responses
5. Analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability

Module	Contents	Hours
01	1.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 1.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. 1.3 Errors in measurement: Types of errors, Effect of component errors, Probable errors.	**08**
02	2.1 **Displacement Measurement**: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) , Nozzle Flapper Transducer 2.2 **Strain Measurement**: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 2.3 **Measurement of Angular Velocity**: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. 2.4 **Acceleration Measurement:** theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers	**08**
03	**3.1 Pressure Measurement:** Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges **3.2 Flow Measurement**: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter **3.3 Temperature Measurement**: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers **3.4 Sensitivity analysis of sensor**-influence of component variation **3.5 Signal conditioning**: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation	**08**
04	**4.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **4.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	**06**
05	**5.1 Transient and steady state analysis of first and second order system.** Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	**06**

06	**Stability analysis** 6.1 Introduction to concepts of stability, The Routh criteria for stability 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots 6.3 State space modeling 6.4 Process control systems, ON-OFF control. P-I-D Control	**12**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition,*McGraw Hill*
2. Mechanical Engineering Measurements, A K Sawhney, *Dhanpat Rai& Sons, New Delhi*
3. Instrumentation & Mechanical Measurements, A K Thayal
4. Control System Engineering by Nagrath IJ and Gopal M, *Wiley EasternLtd.*
5. Modem Control engineering: by KOgata, *Prentice Hall*
6. Control systems by DhaneshManik, Cengage Learning
7. Engineering Metrology and Measurementsby N V Raghavendra and L Krishnamurthy, Oxford University Press
8. Instrumentation and Control System, W. Bolton, Elsevier
9. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
10. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
11. Mechanical Measurements by S P Venkateshan, Ane books, India

Course Code	Course/Subject Name	Credits
MEC 503	**Heat Transfer***	**04**

Objectives

1. To Study basic heat transfer concepts applicable for steady state and transient conditions
2. To Study mathematical modelling and designing concepts of heat exchangers

Outcomes: Learner will be able to…

1. Identify the three modes of heat transfer (conduction, convection and radiation).
2. Illustrate basic modes of heat transfer
3. Develop mathematical model for each mode of heat transfer
4. Develop mathematical model for transient heat transfer
5. Demonstrate and explain mechanism of boiling and condensation
6. Analyse different heat exchangers and quantify their performance

Module	Detailed Contents	Hrs.
01	**Basic concepts of heat transfer:** Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance	04
02	**Conduction:** Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, Heat conduction with heat generation in plane wall, solid cylinder and solid sphere, Critical radius of insulation in cylinder and sphere	08
03	**Heat transfer from Extended Surface:** Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well **Unsteady state heat transfer:** Applications of unsteady state heat transfer, Lumped system Analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts **Numerical methods in heat transfer:**Significance of numerical methods in heat transfer, Finite difference formulation of differential equations, One-dimensional heat conduction.	08
04	**Convection:**Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance **External Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature	10
05	**Radiation:**Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	08
06	**Boiling and Condensation:**Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation **Heat Exchangers:**Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers **Heat Pipe:** Introduction and application	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

ReferenceBooks:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2ndEdition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by FPIncropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy,2ndEdition, PEARSON
5. Heat Transfer by J P Holman, Mcgraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer byR K Rajput, S Chand and company

Course Code	Course/Subject Name	Credits
MEC504	**Dynamics of Machinery***	**4**

Objectives:

1. To acquaint with working principles and applications of Governors / Gyroscope
2. To study static and dynamic force analysis in the mechanisms
3. To familiarise with basics of mechanical vibrations
4. To study the balancing of mechanical systems

Outcomes: Learner will be able to…

1. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems
2. Illustrate basic of static and dynamic forces
3. Determine natural frequency of element/system
4. Determine vibration response of mechanical elements / systems
5. Design vibration isolation system for a specific application
6. Demonstrate basic concepts of balancing of forces and couples

Module	Details	Hrs.
1	**Governors and Gyroscopes:** 1.1 **Governors:** Introduction to Centrifugal and Inertia governors, Force analysis of governors- Porter and Hartnell governors, Performance characteristics of governors, Governors effort and power 1.2 **Gyroscope:** Introduction, Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization. Effect of gyroscopic and centrifugal couples, permissible speeds on curve paths, gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft.	**09**
2	2.1 **Static and Dynamic force analysis,** in slider crank mechanism (neglecting mass of connecting rod and crank), Engine force analysis, Turning moment on crank shaft 2.2 **Dynamically equivalent systems,** to convert rigid body in to two mass with and without correction couple	**06**
3	3.1 **Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters - springs, mass, damper, damper models, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis 3.2 **Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	**08**
4	4.1 **Free Damped Single Degree of Freedom Vibration System:** Viscous damped system - under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping 4.2 **Equivalent Single Degree of Freedom Vibration System:** Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system, Introduction to free multi-degree of freedom vibration systems	**07**
5	5.1 **Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) 5.2 **Vibration Isolation and Transmissibility:** Force Transmissibility, motion transmissibility, typical isolators & mounts.	**10**

	5.3 **Vibration Measuring instruments:** Principle of seismic instruments, vibrometer, accelerometer - undamped and damped, Introduction to conditioning monitoring and fault diagnosis	
6	6.1 **Rotor Dynamics:** Critical speed of single rotor, undamped and damped 6.2 **Balancing:** Static and Dynamic balancing of multi rotor system, balancing of reciprocating masses in In-line engines, V-engines (excluding other radial engines)	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
6. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
7. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
8. Mechanical Vibraitons by G.K.Grover
9. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
10. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
11. Vibration Analysis by P. Srineevasan, TMH
12. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
13. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
14. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York

Course Code	Course/Subject Name	Credits
MEDLO5011	**Press Tool Design**	**4**

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to….

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. Elaborate failure mechanisms of pressed components, safety aspects and automation in press working

Module	Contents	Hours
1	**Introduction to Press Working –** 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.	**08**
2	**Design and Calculations** of Piercing & Blanking Die– 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation) 2.2 Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools 2.3 Different types Die sets and its selection	**14**
3	3.1 **Selection of Material & Hardware –**Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools.	**03**
4	**Bending and Drawing-** 4.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies 4.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup 4.3 Defects in drawn as well as bent parts, Presses selection for drawing/forming operations 4.4 Basic construction and working of Bending and Drawing dies	**12**
5	5.1 **Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies,Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies	**05**
6	**Selection of Presses and its setting –** 6.1 Selection of Press and Press setting for Shearing, Bending, Progressive and Drawing dies, Equipment for Sheet metal operations (Basics only), Overloading of presses (load, energy considerations) 6.2 Introduction to Automation & Safety in Press shop	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Course Code	Course/Subject Name	Credits
MEDLO5012	**Machining Sciences And Tool Design**	**4**

Objectives

1. To familiarise with the basic concepts of machining science like mechanics of machining, tool wear, tool life and surface roughness.
2. To familiarise with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to…

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyse heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyse economics of machining operations

Module	Details	Hrs.
01	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model& modified model for orthogonal cutting, Lee and Shaffer model, Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry	**10**
02	2.1 **Temperatures in metal cutting and cutting fluids:** Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling	**06**
03	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	**06**

	geometrical contribution to roughness, edge finishing, residual stress and micro hardness	
04	4.1 **Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, Experimental methods to find Taylor exponents, Components of product cost,Optimum cutting velocity for minimum cost of production and maximum production rate	**06**
05	5.1 **Design of single point cutting tools** : Different systems of tool nomenclature like MRS, ORS and NRS, Interrelationship among different systems of nomenclature for tool angles, Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders	**08**
06	6.1 **Design of multi point cutting tools :** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application, Profile design of flat and circular form tools,Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow

Course Code	Course/Subject Name	Credits
MEDLO5013	**Design of Jigs and Fixtures**	**4**

Objectives

1. To acquaint with the concepts of planning and writing sequence of operations
2. To acquaint basics of identification and selection of location and clamping points on work-piece
3. To familiarise design principles in designing simple productive and cost effective jigs and fixtures

Outcomes: Learner will be able to…

1. Write methodically, the sequence of operations of simple work-piece
2. Identify and select locating and clamping points on work-piece
3. Demonstrate construction of drill jig
4. Illustrate construction of milling fixture
5. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
6. Design assembly of jigs and fixtures on simple work-piece

Module	Details	Hrs
01	1.1 **Introduction to Tool Design** Production Tooling's Jigs, Fixtures and their difference, their requirement(accuracy, machinability, quantity modifications so as to assist production, Interchange ability, Simplicity, Swarf disposal, Handling, Ease of operation, Skill reduction, Cost reduction), Analysis for Operation planning, sequencing of operations.	**08**
02	**Basic Construction of Jig & Fixture** 1.1 **Location & Locating Devices** Locating principles: Degrees of freedom, Redundant location, Fool-proofing, nesting, Locators: locators that control work piece on flat surfaces, location of cylindrical surfaces, conical locators, centralizers. 1.2 **Clamping & clamping Devices** Requirement of clamping system, Position of clamps, Types of clamps, Clamping devices; examples of typical clamps(multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices), Component distortion under clamping and cutting forces, Material used for different clamping devices of jigs/fixture and recommended hardness	**10**
03	3.1 **Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces /points, cutting tools and means of guiding and supporting Jigs, various types of Jig Bushes, Commonly used drill jigs, Case Study on Design of Drill Jig	**10**
04	4.1 **Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, tool setting block and Tennon's, Case Study on Design of Milling Fixture	**08**
05	5.1 **Introduction to Commonly used Fixtures** Turning Fixture (Chucks, collets, Mandrels) Grinding Fixture, Broaching Fixture, and Welding Fixture	**08**
06	6.1 **Indexing Jig & Fixture** Introduction, Application of indexing, Essential features of an indexing jig /fixture, Indexing Devices	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Jig and Fixture Design Manual, Erik K. Henrikson, Industrial Press
2. An introduction to jig and tool Design, MH A Kempster, 3rd Edition, ELBS
3. Jigs and Fixture, P. H. Joshi, TMH
4. Tool design, C. Donaldson, George H. Lecain, V.C. Goold, TMH
5. Jigs and Fixture Handbook, A.K. Goroshkin, Mir Publication
6. Jigs and Fixture, ASTME
7. Non- Standards Calming Devices, Hiran E. Grant TMH, New Delhi

Subject Code	Subject Name	Credits
MEL 501	**Internal Combustion Engines Lab**	**01**

Objectives:

1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to…

1. Dismantle engine assembly
2. Overhaul and Assemble engine components
3. Perform load test/speed test on engine setup
4. Calculate performance of multi cylinder engine
5. Analyse engine performance and draw heat balance sheet
6. Perform exhaust gas analysis

Part A: Dismantle, overhaul and assemble the following

1. 2 Stroke/ 4 Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

Part B: Performing experiments on engine test rigs

1. Morse Test on petrol engine
2. Speed Test on petrol or/and diesel engine
3. Load Test on diesel engine (engines)
4. Heat Balance test on diesel or petrol engines
5. Experimental determination of Air fuel ratio and volumetric efficiency of the engine
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines
7. Effect of Supercharging on Performance Characteristics of an engine

Term Work

Term work shall consist of minimum 6 exercises, from the list, out of which minimum 4 must be actual experiments from Part B and 1 case study/report (in group of not more than 3 students) on latest trends/developments in IC Engines.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Exercises) :	**15 marks**
2. Case study:	**05 marks**
3. Attendance:	**05 marks**

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEL 502	**Mechanical Measurement and Control**	**1**

Objectives

1. To study calibration of different measuring instruments
2. To study working of mechanical measurement system
3. To familiarise with different types of control systems

Outcomes: Learner will be able to…

1. Calibrate displacement sensors
2. Calibrate pressure and vacuum gauges
3. Measure torque using strain gauges
4. Identify system/process characteristics for standard input responses
5. Identify various types of control systems and time domain specifications
6. Analyse the problems associated with stability

List of Experiments

Sr. No.	Topic
1	Calibration of Displacement sensors like LVDT, Potentiometers etc.
2	Calibration of Pressure Gauges
3	Calibration of Vacuum Gauges
4	Torque measurement using strain gauges
5	Calibration of tachometers
6	Vibration Measurement & Calibration of Accelerometers.
7	Experiments on feedback control systems and servomechanisms
8	System Identification of any one of the sensor
9	Experiment on frequency response system identification
10	Experiment on transient state response of a control system.
11	Experiment on design of PID controller for a system.

(a) Design based experiments shall be encouraged using standard National Instrument/ texas instrument/ dSPACEGmbh/ Arduino or any other platform),**Learners (in a group) may be encouraged for Project Based Learning. Appropriate weightage may be given in term work assessment**

Term Work

Term work shall consist of minimum 8experiments (04 from the measurement group and 4 from the control group),

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) **:** **15 marks**
- Design based experiment: **05 marks**
- Attendance**:** **05 marks**

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
   Practical performance 15 marks
   Oral 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 503	**Heat Transfer Lab**	**01**

Objectives:

1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to…

1. Estimate thermal conductivity of metals/non metals/liquids
2. Compute heat transfer coefficient in natural as well forced convection
3. Measure emissivity of grey body
4. Quantify fin effectiveness/efficiency
5. Analyse heat exchanger performance
6. Demonstrate energy balance for heat exchanger

The laboratory experiments should be based on the following:

Expt.No	Name of Experiments	Time
1	**Conduction: (Any Two)** 1. Measurement of thermal conductivity of metal rod 2. Measurement of thermal conductivity of insulating material 3. Measurement of thermal conductivity of liquid 4. Determination of contact resistance 5. Effect of area on heat transfer	2Hrs
2	**Convection: (Any One)** 1. Measurement of heat transfer coefficient in natural convection 2. Measurement of heat transfer coefficient in forced convection 3. Comparison of heat transfer coefficient of free and forced convection	2Hrs
3	**Radiation: (Any One)** 1. Verification of Stefan Boltzmann Law 2. Measurement of Emissivity of Grey surface	2Hrs
4	**Transient Conduction:** 1. Unsteady state heat transfer in cylinder/rod/wall	2Hrs
5	**Fins: (Any One)** 1. Determination of fin efficiency and fin effectiveness 2. Comparison of fin performance of Various type of fins	2Hrs
6.	**Boiling and Condensation: (Any One)** 1. Measurement of heat transfer coefficient in boiling process of water. 2. Measurement of heat transfer coefficient in condensation of saturated steam.	2Hrs
7	**Heat Exchangers: (Any One)** 1. Estimation of overall heat transfer coefficient and effectivenessof double pipe heat exchanger (parallel flow and Counter flow arrangement) 2. Estimation of overall heat transfer coefficient and effectivenessof shell and tube heat exchanger (parallel flow and Counter flow arrangement) 3. Estimation of overall heat transfer coefficient and effectiveness of plate type heat exchanger.	2Hrs

Assignments: Assignment consisting of at least 3 numerical on each of the following topics

1. Steady state conduction
2. Fins and unsteady state conduction
3. Convection and dimensional analysis

4. Radiation
5. Heat Exchangers

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term work Mark distribution will be as follows:

Laboratory work	15 marks
Assignments	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL504	**Dynamics of Machinery***	**1**

Objectives:

1. To acquaint with working principles and applications of gyroscope and governors
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to…

1. Plot and analyse governor characteristics
2. Analyse gyroscopic effect on laboratory model
3. Estimate natural frequency of mechanical systems
4. Analyse vibration response of mechanical systems
5. Determine damping coefficient of a system
6. Balance rotating mass

Term Work: (Comprises part a and b)

a) List of Experiments: (Minimum Eight)

Sr. No.	Title of Experiment	Laboratory Sessions
1	Experiments on Governors- Porter Governor, Hartnell Governor	2 hrs
2	Experiments on Gyroscope	2 hrs
3	Determine natural frequency of compoundpendulum, equivalent simple pendulum system.	2 Hrs.
4	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel	2 Hrs
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	2 Hrs
6	Experimenton whirling of shaft	2 Hrs
7	Determination of damping coefficient of any system/media	2 Hrs
8	Experimental balancing of single and multi-rotor system	2 Hrs
9	Measurement of vibration response of a system	2 Hrs
10	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2 Hrs

b) Assignment: Minimum two problems on each of the following topics:

1. Governors and Gyroscope
2. Static and dynamic force analysis
3. Vibration, isolation and control
4. Vibration measuring instruments
5. Rotor dynamics

Project Based Learning may be incorporated by judiciously reducing number of assignments

Term Work

The distribution of marks for term work shall be as follows:

• Laboratory work	:	15 marks.
• Assignments	:	05 marks.
• Attendance	:	05 Marks.

Course Code	Course/Subject Name	Credits
MEL 505	**Manufacturing Sciences Lab**	**1**

Objectives:

1. To study conventional machining operations
2. To familiarise with CNC machining operation
3. To acquaint with Non Traditional machining operations

Outcomes: Learner will be able to…

1. Estimate machining time for simple and taper turning operations on lathe
2. Estimate machining time for threading/knurling operations on lathe
3. Estimate machining time for various machining operations on shaper
4. Perform NC, CNC and DNC machining operations
5. Write CNC program for different operations
6. Identify machining parameters for various Non Traditional machining operations

Sr No.	Details
1	Introduction to machining operations
2	Introduction to lathe machine (other than plain turning operation) and shaping machine
3	Machining and machining time estimation for taper turning
4	Machining and machining time estimation for thread cutting
5	Machining and machining time estimation for internal thread cutting
6	Machining and machining time estimation for knurling
7	Machining and machining time estimation for eccentric turning
8	Machining of hexagon and square in shaping machine
9	NC, CNC, DNC machining operations
10	CNC programming for Turning and Drilling operations
11	Different Non Traditional machining operations with process parameters

Term Work:

All the assignments mentioned above with relevant sketches.

Distribution of marks for Term work shall be as follows:

All the above listed assignments:	**20 marks**
Attendance:	**05 marks**

Subject Code	Subject Name	Credits
MEL506	**Business Communication & Ethics**	**02**

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Outcomes: Learner will be able to…

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	**Detailed Contents**	**Hrs.**
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	**Employment Skills**	**07**
6.1	Group Discussion	

6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

Assessment:

List of Assignments

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list.

The distribution of marks for term work shall be as follows:

Book Report	**10 marks**
Assignments:	**10 marks**
Project Report Presentation:	**15 marks**
Group Discussion:	**10 marks**
Attendance:	**05 marks**

References:

1. Fred Luthans, “Organizational Behavior”, Mc Graw Hill,
2. Lesiker and Petit, “Report Writing for Business”, Mc Graw Hill
3. R.Subramaniam, “Professional Ethics” Oxford University Press
4. Huckin and Olsen, “Technical Writing and Professional Communication”, McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, “Personal Development for Life and Work”, Thomson Learning, 12th Edition
7. Heta Murphy, “*Effective Business Communication*” , Mc Graw Hill, edition
8. R.C Sharma and Krishna Mohan, “*Business Correspondence and Report Writing”,*
9. Raman Sharma, *Communication Skills*, Oxford University Press
10. B N Ghosh, “*Managing Soft Skills for Personality Development*”, Tata McGraw Hill Lehman,
11. Dufrene, Sinha, “*BCOM*”, Cengage Learning, 2nd edition
12. Bell . Smith, “Management Communication” Wiley India Edition, 3rd edition.
13. Dr. K. Alex ,”Soft Skills”, S Chand and Company
14. Robbins Stephens P., “Organizational Behavior”, Pearson Education
15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course/Subject Name	Credits
MEC 601	**Metrology and Quality Engineering**	**4**

Objectives:

1. To acquaint with measuring equipment used for linear and angular measurements.
2. To familiarize with different classes of measuring instruments and scope of measurement in industry and research
3. To acquaint with operations of precision measurement, instrument/equipment for measurement
4. To inculcate the fundamentals of quality concepts and statistics in metrology

Outcomes: Learner will be able to…

1. Demonstrate inspection methods and different gauges
2. Illustrate working principle of measuring instruments and calibration methodology
3. Illustrate basic concepts and statistical methods in quality control
4. Demonstrate characteristics of screw threads, gear profile, and tool profile
5. Illustrate the different sampling techniques in quality control
6. Illustrate different nondestructive techniques used for quality evaluation

Module	Details	Hours
1	1.1 **Introduction to Metrology:** Fundamental Definitions, Types of Standards, Precision and Accuracy, Measurement Errors, linear measurements by Vernier calliper, micrometer, slip gauges, Angular Measurement: Universal bevel protractor, clinometers, sine bar, angle gaugescase studies on Industrial and Research Applications and Scope 1.2 **Introduction to Nano-Metrology**	06
2	1.3 **Design of Gauges :** Limits, Fits, Tolerances, Types of Gauges, Taylor's Principle of Limit Gauges, IS 919 for design of gauges 1.4 **Comparators :** Definition, Classification, Working principle of Mechanical, Opto-mechanical, Pneumatic and Electrical/Electronic comparators with advantages, limitations and uses 1.5 **Surface Texture measurement:** Surface roughness, Waviness, Roughness Parameter Ra, Rz, RMS etc., working of Tomlinson surface meter, Taly-surf surface roughness tester, Surface roughness symbols 1.6 **Flatness Test measurement by Interference principle:** Concept of Flatness, Interferometer principle for measurement, Optical Flats – study of Surface textures under monochromatic light source, fingertip test technique	14
3	3.1 **Screw Thread Measurement :** Screw threads Terminology, screw thread errors, Effective diameter measurement of screw thread by Floating Carriage micrometer 3.2 **Gear Measurement :** Gear Terminology, Gear errors, Measurement by Parkinson Gear tester and Gear tooth Vernier Calliper 3.3 **Special Measuring Instruments :** Measurement by Tool Maker's Microscope, Optical Profile Projector, CMM and Autocollimator	12

4	4.1 **Quality Engineering** Introduction to Quality, Classification of Quality Tools, Quality of Design, Quality of Conformance, Compromise between Quality and Cost, Introduction to Six Sigma 4.2 **SQC & SQC tools** Statistics in Quality control, Variables and Attributes data, Process Capability, Control charts for variables and for attribute data($\bar{X}$and R-Chart, p-chart np-chart, c-chart, U-chart), Applications of SQC in engineering – case studies	08
5	5.1 **Sampling Techniques** Advantages of Sampling Inspection, operating characteristic (OC) curve. Choosing OC curve for appropriate sampling plan, acceptance sampling 5.2 **Role of computers in metrology**	04
6	6.1 **Non-destructive Testing** Visual, Dye Penetrant, Magnetic Particle, X ray Radiography, Ultrasonic Testing, Eddy Current testing methods.	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Engineering Metrology,K.J. Hume, Kalyani Publications
2. Mechanical Measurements and Metrology by RKJain, Khanna Publishers
3. A text book of Engineering Metrology by IC Gupta, DhanpatRai Publications
4. Metrology and Measurement by Anand,Bewoor and VinayKulkarni, McGraw Hill
5. Engineering Metrology and Measurement by N V Raghavendra and Krishnamurthy, Oxford University Press
6. Engineering Metrology and Measurements, Bentley, Pearson Education
7. Statistical Quality Control by AL Grant, McGraw Hill, New York
8. Statistical Quality Control by R C Gupta, Khanna Publishers
9. Juran on Planning for Quality,Juran J M,TheFree Press, 1988.
10. Statistical Quality Control by M Mahajan, Dhanpat Rai and Sons

Course Code	Course Name	Credits
MEC602	**MACHINE DESIGN – I***	**4**

Objective:

1. To study basic principles of machine design
2. To acquaint with the concepts of design based on strength & rigidity
3. To familiarize with use of design data books & various codes of practice
4. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations
2. Illustrate basic principles of machine design
3. Design machine elements for static as well as dynamic loading
4. Design machine elements on the basis of strength/ rigidity concepts
5. Use design data books in designing various components
6. Acquire skill in preparing production drawings pertaining to various designs

Modules	Details	Hrs.
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers	06
2	**Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. **Thick Cylinders:** Design of thick cylinders subjected to an internal pressure using Lame's equation	06
3	**Design against static loads:**Cotter joint, Knuckle joint, Turn buckle, Bolted and welded joints under eccentric loading;Power Screw – screw presses, C-clamps along with the Frame, Screw Jack	12
4	**Design against fluctuating loads:** variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses	06
5	**Design of Shaft:** power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria **Keys**: Types of Keys and their selection based on shafting condition **Couplings:** Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	11
6	**Design of Springs:** Helical compression, Tension Springs under Static and Variable loads, Leaf springs	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

Course Code	Course Name	Credits
MEC603	**Finite Element Analysis**	**4**

Objectives:

1. To familiarise with concepts of FEM
2. To study the applicability of FEM to engineering problems
3. To acquaint with application of numerical techniques for solving problems

Outcomes: Learner will be able to…

1. Solve differential equations using weighted residual methods
2. Develop the finite element equations to model engineering problems governed by second order differential equations
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system
6. Use commercial FEA software, to solve problems related to mechanical engineering

Module	Details	Hrs.
01	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing equations, Differential equations in different fields 1.3 Approximate solution of differential equations, Weighted residual techniques, Boundary value problems	**08**
02	**FEA Procedure:** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the, Finite Element Method 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', transformation and assembly concepts	**08**
03	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams 3.4 Solution of one dimensional structural and thermal problems using FE Software, Selection of suitable element type, modelling, meshing, boundary condition, convergence of solution, result analysis, case studies	**10**
04	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element, four node quadrilateral element, eight node quadrilateral element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoparametric, super parametric elements, Compatibility, Patch test, Convergence criterion, sources of errors	**08**

05	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axisymmetric problems 5.2 Jacobian matrix, stress analysis of CST and four node Quadratic element	**08**
06	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Text book of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by JNReddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu,Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John-Wiley Sons
7. The Finite Element Method in Engineering by SSRao, Butter WorthHeinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Course Code	Course/Subject Name	Credits
MEC604	**Refrigeration and Air Conditioning**	**4**

Objectives

1. To study working and operating principles of Air Refrigeration, Vapour Compression and Vapour Absorption system
2. To study components of refrigeration and air conditioning systems
3. To study controls and applications of refrigeration and air conditioning

Outcomes: Learner will be able to…

1. Demonstrate fundamental principles of refrigeration and air conditioning
2. Identify and locate various important components of the refrigeration and air conditioning system
3. Illustrate various refrigeration and air conditioning processes using psychometric chart
4. Design Air Conditioning system using cooling load calculations.
5. Estimate air conditioning system parameters
6. Demonstrate understanding of duct design concepts

Module	Detailed Contents	Hrs.
01	**Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Co- efficient of Performance, Energy Efficiency Ratio (EER), and BEE star rating Air refrigeration systems: Bell Coleman cycle, applications Aircraft air refrigeration systems: Need for aircraft refrigeration, Simple, Bootstrap including evaporative cooling, Reduced ambient, Regenerative air cooling system, Comparison of these systems based on DART rating.	08
02	**Vapour Compression Refrigeration System**: Simple vapour compression cycle, Effect of liquid sub cooling& superheating, effect of evaporator and condenser pressures, methods of subcooling, use of P-h charts, Actual VCR cycle, Use of P-h Charts, Comparison between air-cooled and water-cooled condenser based air conditioning systems, Types of condensers, evaporators, expansion devices and Compressors **Cooling tower:** Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance **Refrigerants**: Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties, Secondary refrigerants, ODP and GWP, Montreal protocol and India's commitment, Recent substitutes for refrigerants	12
03	**Other Refrigeration Systems**: Vapour Absorption Refrigeration, Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system, **Non-Conventional Refrigeration Systems:** Thermoelectric Refrigeration, Thermo-acoustic Refrigeration, Vortex Tube Refrigeration	06
04	**Psychrometry:** Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning	05
05	**Design of Air Conditioning Systems**: Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality, Green Buildings	12

	Duct Design Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating	
06	**Controls and Applications**: Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation ,Freeze Drying, A/c in textile ,printing pharmaceutical industry and Hospitals , Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1 Refrigeration and air-conditioning – C P Arora, TMH
2 Principles of refrigeration – R J Dossat, Willey Eastern Publication
3 Refrigeration and air-conditioning – W F Stoeker and J W Jones, TMH
4 Modern Air-conditioning practice – C P Arora, TMH
5 Refrigeration and air-conditioning- Manohar Prasad, New Age Int (P) Ltd
6 Basic Refrigeration and air-conditioning- P.Ananthanarayana, TMH
7 ASHRAE Handbook of Fundamentals
8 ASHRAE Handbook of Systems
9 ASHRAE Handbook of Equipment
10 ISHRAE Air Conditioning Handbook
11 ISHRAE Refrigeration Handbook

Course Code	Course Name	Credits
MEDLO6021	**Mechatronics**	**4**

Objectives

1. To study key elements of Mechatronics system and its integration
2. To familiarise concepts of sensors characterization and its interfacing with microcontrollers
3. To acquaint with concepts of actuators and its interfacing with microcontrollers
4. To study continuous control logics i.e. P, PI, PD and PID
5. To study discrete control logics in PLC systems and its industrial applications

Outcomes: Learner will be able to…

1. Identify the suitable sensor and actuator for a mechatronics system
2. Select suitable logic controls
3. Analyse continuous control logics for standard input conditions
4. Develop ladder logic programming
5. Design hydraulic/pneumatic circuits
6. Design a mechatronic system

Module	Detailed Contents	Hrs.
1	**Introduction of Mechatronics and its block diagram representation** Key elements of mechatronics, Applications of Mechatronics domestic, industrial etc. Representation of mechatronic system in block diagram and concept of transfer function for each element of mechatronic system, Reduction methods and its numerical treatment for represented block diagram	08
2	**Selection of Sensors & Actuators** Sensors: Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
3	**Data Acquisition, Signal Conditioning & Microcontroller System Theory:** Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Convertor) Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Convertor) R-2R circuit and DAC resolution Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	08
4	**Pneumatics and hydraulics:** Hydraulic and pneumatic devices: Different types of valves, Actuators and auxiliary elements in Pneumatics and hydraulics, their applications and use of their ISO symbols, Synthesis and design of circuits (up to 2 cylinders)–pneumatic, electro- pneumatics and hydraulics, electro-hydraulics	08
5	**Control System** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	08
6	**Discrete Control System PLC (Programming Logic Control)Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc
2. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
3. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
4. Introduction to Mechatronics and Measurement Systems, Alciatore and HistandTata McGraw-Hill
5. Mechatronics, Necsulescu, Pearson education
6. Mechatronics - Electromechanics and Control Mechanics , Mill Springer-Verlag
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
8. Mechatronics - Electronics in products and processes , Bradley, et al. Chapman and Hall
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
10. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
11. Pneumatic Circuits and Low Cost Automation by Fawcett JR
12. The Art of Electronics, Horowitz and Hill Cambridge, University Press
13. Electromechanical Design Handbook , Walsh, McGraw-Hill
14. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
15. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, Addison Wesley
16. Principles and Applications of Electrical Engineering , Rizzoni, Irwin Publishing
17. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , KammIEEE
18. Modeling and control of Dynamic Systems, Macia and Thaler, Cengage Learning, India Edition
19. Mechatronics, A. Smaili, F. Mrad, OXFORD Higher Education.
20. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
21. Industrial Hydraulics: Pippenger
22. Vickers Manual on Hydraulics
23. Computer Numerical Control of Machine Tools: Thyer. G.R.
24. Pneumatic Applications: Deppert Warner & Stoll Kurt
25. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
26. Hydraulics and Pneumatics for Production: Stewart
27. Hydraulic Valves and Controls: Pippenger
28. Fundamentals of pneumatics: Festo series
29. Automatic Control Engineering: Francis. H. Raven.
30. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
31. Mechatronics, HMT
32. System Identification: Theory for the User (2nd Edition) , Lennart Ljung
33. Design with Microprocessors for Mechanical Engineers, StifflerMcGraw-Hill

Course Code	Course/Subject Name	Credits
MEDLO6022	**Robotics**	**04**

Objectives:

1. To study the basics of robotics and its control
2. To study various design principles of robotics through kinematic analysis, workspace analysis, and trajectory planning
3. To study applications of robots in industrial inspection and material handling
4. To study the role of a robot as a humanoid

Outcomes: Learner will be able to…

1. Demonstrate the basic functioning of a robot
2. Identify various components of robots
3. Carryout kinematic analysis, workspace analysis, and trajectory planning for a robot
4. Identify suitable sensors/actuators for robot
5. Select an appropriate robot for given industrial inspection and material handling systems.
6. Illustrate various aspects of a robot as a humanoid

Module	Details	Hrs.
01	**Introduction** Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Actuators and sensors, Drives and transmission systems, End effectors, Applications of robots	08
02	**Kinematics of Robots** **Direct:** Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots. **Inverse:** The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot. **Mobile Robot Kinematics** Introduction, Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Mobile robot maneuverability, Degree of mobility, Degree of steerability, Mobile robot workspace, Degree of freedom, Holonomic robots, Path and trajectory considerations, Motion control, Open loop control, Feedback control.	10
03	**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - Continuous path motion, Interpolated motion, Straight line motion and Cartesian space technique in trajectory planning.	10
04	**Sensors & Actuators** Sensors: Selection of sensors (Displacement, temperature, acceleration ,force/pressure) based on static and dynamic charecterstics, Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08

05	**Robots for Inspection and Material Handling** Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations Concepts of material handling, Principles and considerations in material handling systems design, Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and Hoists, Advanced material handling systems, Automated guided vehicle systems, Automated storage and retrieval systems, Bar code technology, Radio frequency identification technology	08
06	**Humanoids** Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, and sound, Vision, Tactile Sensing, Models of emotion and motivation, Performance, Interaction, Safety and robustness, Applications, Case studies	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Yoram Korean, “Robotics for engineers”, McGrew Hill Co.
2. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
3. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press
4. R.K. Mittal and I.J. Nagrath, “Robotics and Control”, TMH Publications
5. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning
6. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robtics and Automation Sensor – Based integration, Academic Press
7. K.S.Fu, R.C.Gonzalex, and C.S.G.Lee, “Robotics Control Sensing, Vision and Intelligence”, McGrew hill Book co.
8. Hartenberg and Denavit, “Kinematics and Synthesis of linkages”, McGrew Hill Book Co.
9. A.S. Hall, “Kinematics and Linkage Design”, Prentice Hall
10. J.Hirchhorn, “Kinematics and Dynamics of Machinery”, McGrew Hill Book Company

11. P.A. Janaki Raman, “Robotics and Image Processing An Introduction”, Tata McGraw Hill Publishing company Ltd.
12. Richard D Klafter, Thomas A Chmielewski, and Michael Negin, “Robotics Engineering – An Integrated Approach”, Eastern Economy Edition, Prentice Hall of India P Ltd.
13. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA
14. Alonzo Kelly, Karl Iagnemma, and Andrew Howard, “Field and Service Robotics”, Springer
15. Riadh Siaer, “The future of Humanoid Robots- Research and applications”, Intech Publications

Course Code	Course Name	Credits
MEDLO6023	**Industrial Automation**	**4**

Objectives:

1. To study the need for the automation, its advantages and limitations
2. To study the basic functional elements of automation
3. To familiarise with the levels of automation and strategies of automation
4. To acquaint with control of mechanical operations involving pneumatic, electric, hydraulic and electronic systems

Outcomes: Learner will be able to…

1. Demonstrate basics of industrial automation
2. Identify various types of automation
3. Demonstrate use of automated controls using pneumatic and hydraulic systems.
4. Illustrate the control systems in automated system.
5. Demonstrate applicability of PLC in process industry
6. Design elecrto-pneumatic circuits

Module	**Detailed Contents**	**Hrs.**
01	**Introduction to Automation**: Definition and fundamentals of automation, reasons for Automating, basic elements of an automated system: Power, Program and control system **Advanced automation functions:** safety, maintenance & repair diagnosis, error detection and recovery **Levels of automation** **Automation principles and strategies:** USA principle, ten strategies of automation and production system, automation migration strategy	06
02	**Mechanization and Automation:** Mechanization and automation, product cycle, hard Vs flexible automation, Capital- intensive Vs low cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc.	08
03	**Pneumatics and hydraulics:**Hydraulic and pneumatic devices-Different types of valves , Actuators and auxiliary elements in Pneumatics & hydraulics , their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	14
04	Sensors & Actuators Sensors: Selection of sensors (Displacement, temperature, acceleration, force /pressure) based on static and dynamic characteristics Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	06

05	**Industrial control systems:** Process industries versus discrete manufacturing industries, Continuous verses discrete control, Computer process control, Forms of computer process control Discrete control using PLC- discrete process control, Programmable logic controller, its architecture,ladder digs, Ladder Logic Programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	10
06	**Robots and their applications:** Introduction to robots, Types, Classifications, Selection of robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications of robots	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. M.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education,New Delhi
2. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, “Product Design for manufacture and Assembly”, CRC Press
3. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
4. Yoram Korean, “Robotics for engineers”, McGrew Hill Co
5. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications”, Prentice Hall.
6. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
7. Industrial Hydraulics: Pippenger
8. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
9. Pneumatic Circuits and Low Cost Automation: by Fawcett J.R.
10. Fundamentals of pneumatics: Festo series

Course Code	Course/Subject Name	Credits
MEL601	**Metrology and Quality Engineering**	**1**

Objectives:

1. To familiarise with working of gauges
2. To acquaint with gear parameter measurement
3. To acquaint with operations of precision measurement, instrument/equipment for measurement
4. To inculcate the fundamentals of quality concepts and statistics in metrology

Outcomes: Learner will be able to…

1. Measure linear and angular dimensions
2. Measure surface roughness
3. Measure various parameters of gear tooth profile
4. Use optical profile projector for measurement
5. Use various instruments for measurement of screw threads
6. Measure flatness by Autocollimator / Interferometry method

Six Experiments need to be performed on the below mentioned topics:

Sr. No.	**Topic**
1	Vernier Calliper, Micrometer and Bevel Protractor for linear and angular measurement
2	Surface measurement by Surface roughness tester
3	Gear measurement – Gear tooth Vernier calliper / Parkinson gear tester
4	Screw Thread Measurement – screw thread Micrometer, Floating carriage micrometer /bench micrometer
5	Optical profile projector for miniature linear / angular measurements of screw / gear or components
6	Tool maker's microscope for linear / angular measurement of single point tools
7	Comparator – Mechanical / Pneumatic type
8	Flatness measurement by Autocollimator / Interferometry method
9	QC charts for 50 sample readings of OD / ID of specimen and printouts

Term-Work

Consists of minimum six experiments from the above list and presented with Aim, Apparatus/equipment's, and Introduction, Working principle, Diagram, method, observation table, Analysis, Results and conclusion/inferences.

Also, minimum 5 assignments to help smooth conducting of laboratory exercises and one case study relevant to contents

Project Based Learning may be incorporated by judiciously reducing number of assignments

Distribution of marks for term work shall be as follows:

Laboratory work**:**	**15 marks**
Assignments:	**05 marks**
Attendance**:**	**05 marks**

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
   a) Practical performance ……**15** marks
   b) Oral …… ………………. .**10** marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL602	**Machine Design –I ***	**1**

Objectives:

1. To study the basic design principles
2. To familiarize with use of design data books & various codes of practice
3. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Design shaft under various conditions
2. Design Knuckle Joint / cotter joint
3. Design Screw Jack/C-clamp along with frame
4. Design Flexible flange couplings/ Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardise the designed dimensions

Term Work: (Comprises a & b)

a) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on **A3 size sheets**.

1) Knuckle Joint / cotter joint
2) Screw Jack
3) Flexible flange couplings
4) Leaf springs
5) C-clamps along with the Frame

b) Assignment: Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

1) Bolted and welded joints
2) Combined stresses problem using theory of failure.
3) Shaft design (solid and hollow shaft)
4) Design against fluctuating loads (finite and infinite life)

The distribution of marks for term work shall be as follows:

• Part - a :	15 marks.
• Part--b :	05 marks.
• Attendance:	05 Marks.

Course Code	Course Name	Credits
MEL603	**Finite Element Analysis**	**1**

Objectives:

1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to…

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

a) List of Experiments: Students should use the commercial software or programmes form the text-books or self-developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal. The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.

b) Course Project:

A group of not more than four students, shall do Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.

The distribution of marks for term work shall be as follows:

Part a:	15 marks.
Part b:	05 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
   a) Practical performance ……**15** marks
   b) Oral …… ………………. .**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEL604	**Refrigeration and Air Conditioning TW/Practical**	**1**

Objectives

1. To study operating principles of Vapour Compression system
2. To study components of refrigeration and air conditioning systems
3. To study controls and applications of refrigeration and air conditioning

Outcomes: Learner will be able to…

1. Demonstrate fundamental principles of refrigeration and air conditioning
2. Identify and locate various important components of the refrigeration and air conditioning system
3. Represent various refrigeration and air conditioning processes using psychometric chart
4. Operate and maintain refrigeration system
5. Operate and maintain air conditioning system
6. Simulate VCRS

Part A: List of Experiments

Trial on window air conditioner or Air Conditioning Test Rig
Trial on water cooler/Refrigeration Test Rig
Trial on Ice Plant
Trial on cooling tower

Part B: Demonstrations/Reports/Assignments/Simulations

Demonstration of domestic refrigerator along with wiring diagram
Demonstration of leak detection, evacuation and charging of refrigerant
Report on different protocols to regulate global warming
Visit report of Refrigeration establishment like Cold storage plant or ice plant or air-conditioning plant
Assignment on humidification and dehumidification, heating and cooling, mixing of two air streams
Steady state Simulation of VCR system with developed code or any analytical software

Term work

Term work shall consists of minimum Three Laboratory Experiments, at least one demonstration exercise, Industrial Visit Report, at least one assignment consisting of numerical based on Refrigeration and Air Conditioning and one simulation exercise on VCR

The distribution of marks for term work shall be as follows:

Part a:	15 marks.
Part b:	05 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Practical examination (in a group of not more than 5 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:
    a. Practical performance ……**15** marks
    b. Oral …… …………………**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 605	**Mechatronics Lab**	**01**

Objectives

1. To study sensors and actuators
2. To study control systems
3. To study automation

Outcomes: Learner will be able to…

1. Demonstrate implementation of interfacing sensors and actuators using microcontrollers
2. Demonstrate of interfacing various utilities with microcontrollers
3. Demonstrate discrete control system using PLC microcontroller
4. Design and develop a control system for specific use
5. Implement program to PLC system and demonstrate its application
6. Develop pneumatic circuits for a specific system

The laboratory experiments should be based on the following

Group 1: Sensors & Actuators

1. Theoretical & Experimental Implementation of Interfacing of Sensors using microcontroller and determination of sensor characteristics such as Static Characteristics (Sensitivity, Accuracy, Range, Resolution etc.), Dynamic Characteristics (Transient Response and Frequency Response)
2. Measurement and Calibration of Load / Force (*It is suggested to determine all characteristics of sensor mentioned in previous experiments)*
3. Measurement, Calibration and Comparison of Temperature Sensors (Thermocouple, RTD and Thermistor) *(It is suggested to determine all characteristics of sensor mentioned in previous experiments)*
4. Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table *(It is suggested to program to vary the position of rotary or XY table and compare the positioning accuracy using standard calibrated angular or linear sensor)*
5. Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup *(It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics)*
6. Interfacing of Water Heater with microcontroller and its programming for determination of its transient and steady state characteristics *(It is suggested to program to vary the input current to heater and determine its transient and steady state characteristics)*

Group 2: Control Systems

1. Experimental demonstration of Discrete control system using PLC microcontroller using standard PLC demo setup (Bottle filling Machine, Traffic Light Signal, Water heater and its stirring System etc.). *(here it is suggested to carry out ladder programing and demonstrate its operation)*
2. System Identification of Spring Mass Damper System for step input & harmonic input and determination of poles and zeros of system. *(Spring Mass Damper setup with all required position sensors mounted is to be characterized for step input, it is suggested to determine transfer function (i.e. input output relation) of the setup and plotting its transient and frequency response (Bode plot))*
3. Design & Experimental Implementation of PID control strategy for Spring Mass Damper Setup to control precisely position of mass. (*it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system*).
4. Design & Experimental Implementation of PID control strategy for DC motor speed control under varying loading conditions and effect of variation of load is to be studied.
5. Design & Experimental implementation of PID control strategy for Real Time Temperature Control of furnace *(it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system)*.
6. Modeling and design of control system for quarter car suspension model using any suitable modeling and analysis software.

Group 3: Automation

1. Real time Logic implementation for traffic Control demo setup and it is necessary to carry out ladder programming and implement program to PLC system and demonstrate its operations
2. IOT: Real time interfacing of sensors (temperature, humidity, position, level etc.) and actuator (stepper motor, dc motor, servo motor etc.) with microcontroller and Ethernet shield and controlling the actuator and monitoring of sensor output remotely using internet.
3. Robotics: Real Time demonstration of line following robot using standard robotic kit
4. Demonstration and study of functions of components of robotics arm.
5. Visualization of DH parameters in Roboanalyzer.(*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com)
6. Designing sequential operation for two cylinders using electro-hydraulic circuits
7. Designing sequential operation for two cylinders using electro- pneumatic circuits
8. Development of pneumatic circuits to understand pneumatic components and their working

Term work

Term work shall consists of minimum Nine Experiments, Three from each group mentioned above

The distribution of marks for term work shall be as follows:

Laboratory Work:	20 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/oral based on contents
2. Practical examination (in a group of not more than 4 students) duration is 2 hours
3. Distribution of marks for practical/Oral examination shall be as follows:
    a. Practical performance ……**15** marks
    b. Oral …… …………………**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEC701	**Machine Design – II**	**4**

Objective:

1. To acquaint with functional and strength design principles of important machine elements
2. To familiarise selection of standard elements such as rolling element bearings, belts etc.

Outcomes: Learner will be able to…

1. Select appropriate gears for power transmission on the basis of given load and speed
2. Design gears based on the given conditions.
3. Select bearings for a given applications from the manufacturers catalogue.
4. Select and/or design belts and flywheel for given applications
5. Design cam and follower mechanisms.
6. Design clutches and brakes

Module	Details	Hrs.
01	**Design of Gears:** 1.1 **Gears:** Design of spur, helical, bevel and worm gears with strength, wear and thermal considerations 1.2 **Gear Box:** Two stage Gear box with fixed ratio consisting of spur, helical and bevel gear pairs: gear box housing layout and housing design	**14**
02	2.1 **Rolling Contact Bearings:** Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)	**05**
03	1.1 **Sliding Contact Bearings:** Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydro static bearings, Types and selection of Mechanical seals	**05**
04	4.1 **Design of Cams and Followers:** Design of Cam and Roller follower mechanisms with spring and shaft	**06**
05	5.1 **Design and selection of Belts:** Flat and V-belts with pulley construction 5.2 **Design of Flywheel** – Introduction, Fluctuation of energy and speed, turning moment diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms, Construction of flywheel 5.3 Design and selection of standard roller chains	**10**
06	6.1 **Design of Clutches:** Introduction, types, Basic theory of plate and cone type clutches, Design of single plate, multi-plate and cone clutches, with spring, lever design and thermal, wear considerations. 6.2 **Design of Brakes:** Design of single shoe brake	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

Course Code	Course/Subject Name	Credits
MEC702	**CAD/CAM/CAE**	**04**

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to…

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects & store and manage data.
3. CAM Toolpath Creation and NC- G code output.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

Modules	Details	Hrs.
01	**Computer Graphics and Techniques for Geometric Modeling** Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	**Transformation, Manipulation & Data Storage** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering. **Application Programming Interface (API)** Concept of customizing applications by writing programs, Fusion Object Model, Creating Scripts and Add-Ins, Document and assembly structure, Attributes, Creating Programs for Assemblies, Joint, B- Rep & Geometry.	08
03	**Design to Manufacturing (CAM)** 2D Machining Strategies, 3D Machining Strategies, Fixture Component Terminology, Work Coordinate System Terminology, Create setups, Apply 2D operations, Facing, 2D adaptive clearing, 2D contour. Chamfer milling, Bore ,Tool simulation and stock material removal , Produce setup sheets , Product NC code via post processing,	08
04	**Computer Aided Engineering (CAE)** Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08
05	**Computer Integrated Manufacturing & Technology Driven Practices** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08

06	**Rapid Prototyping and Tooling** Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*

14. “Flexible Manufacturing Systems” by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. “Mathematical Elements for Computer Graphics”, Rogers D F I and Adams J A, McGraw-Hill.
17. “Computer Integrated Manufacturing Hand Book” by Eric Teicholz, Joel N. Orr, McGraw Hill International Editions
18. “Rapid Prototyping” Chee Kai ChuaWorld Scientific Publishing
19. “Rapid Prototyping:Principles and Applications” RafiqNoorani, Wiley
20. “Rapid Prototyping:Principles and Applications” C.K. Chua,K.F.Leong, C.S. Lim World Scientific Publishing
21. “Rapid Prototyping and Manufacturing” P. F. Jacobs, Society of Manufacturing Engineers.

Course Code	Course/Subject Name	Credits
MEC703	**Production Planning and Control**	**4**

Objectives:

1. To provide an exposure to Production Planning & Control (PPC) and its significance in Manufacturing Industries
2. To give insight into the ongoing & futuristic trends in the control of inventory
3. To appraise about need and benefits of planning functions related to products and processes
4. To give exposure to production scheduling and sequencing so as to optimise resources

Outcomes: Learner will be able to…

1. Illustrate production planning functions and manage manufacturing functions in a better way
2. Develop competency in scheduling and sequencing of manufacturing operations
3. Forecast the demand of the product and prepare an aggregate plan
4. Develop the skills of Inventory Management and cost effectiveness
5. Create a logical approach to Line Balancing in various production systems
6. Implement techniques of manufacturing planning and control

Module	Details	Hrs
1	**Concepts of PPC:** 1.1. Manufacturing systems- components and types, need for PPC, functions of PPC, relationship of PPC with other functions 1.2. Factors influencing PPC in the organization, manufacturing methods- projects & jobbing products, batch, mass / flow production, continuous / process production. 1.3. Organization of PPC- status of PPC department, internal structure, degree of centralization, PPC as an integrated approach 1.4. Prerequisites of PPC – data pertaining to design, equipment, raw materials, tooling, performance standards, labour and operating systems	**06**
2	**Forecasting, Aggregate planning, Capacity planning** 2.1. Forecasting: Need for forecasting, role of forecasting in PPC, forecasting methods of qualitative type like judgment techniques. Forecasting methods of quantitative types like time series analysis, least square method, moving averagemethod, exponential smoothing method. Forecasting Errors and Forecasting Bias 2.2. Aggregate planning : Concept of aggregate planning, decision rules, strategies and methods 2.3. Capacity Planning: Measurement of capacity, Measures of capacity, Factors influencing effective capacity, short range, medium range and long range capacity planning, Rough cut capacity planning.	**08**
3	**Inventory Control:** 3.1. Basic concepts of inventory, Types of inventory, purpose of holding stock and influence of demand on inventory, Costs associated with Inventory management. 3.2. Inventory Models: Deterministic models - instantaneous stock replenishment model, Production model, planned shortages and price discount model, Probabilistic models- fixed quantity system(Q-system) and Fixed period system (p-system) 3.3. Selective Inventory Control techniques - ABC analysis, HML analysis and VED analysis	**08**
4	**Process Planning and Line Balancing** 4.1 Process planning: Prerequisite information requirement, steps in process planning, process planning in different situations, documents in process planning, machine / process selection & Computer Aided Process Planning 4.2 Line Balancing: objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	**08**
5	**Production Scheduling and Sequencing** 5.1 **Scheduling**: Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems.	**10**

	Project scheduling by using elements of network analysis –PERT & CPM, cost analysis & crashing, resource leveling 5.2 **Sequencing:** Product sequencing, dispatching, progress report & expediting and control. Johnson's Rule for optimal sequence of N jobs on 2 machine. Process n Jobs on 3 Machines (n/3 problem) and Jackson Algorithm. Processing of 2 Jobs on m Machine (2/m) problem	
6	**MRP, MRP II, ERP** 6.1. Material Requirement planning(MRP) and Manufacturing Resource Planning (MRP-II) - general concepts, types of demands, Inputs to MRP, MRP objectives, outputs of MRP, Estimation of planned orderreleases. Benefits and Limitations of MRP II 6.2. Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, critical success factors of ERP, Case studies of success and failure of ERP implementations, ERP packages	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Production Planning and Control – Samuel Eilon.
2. Production Planning and Control – L C Jamb
3. Production Planning and Control, W. Boltan-Longman Scientific & Technical
4. Production Systems- Planning, Analysis& Control, James. L. Riggs-John Wiley &Sons
5. Manufacturing Planning and Control Systems, Thomas E. Vollman, WilliamL.Berry& Others- Galgotia Publishers
6. Manufacturing Process Planning and Systems Engineering, AnandBewoor-Dreamtech Press
7. Production and Operations Management, S.N.Chary- TMH publishing company
8. Modernization & Manufacturing Management, L.C. Jhamb - Everest PublishingHouse

Course Code	Course/Subject Name	Credits
MEDLO7031	**MECHANICAL VIBRATION**	**4**

Objectives:

1. To study basic concepts of vibration analysis
2. To acquaint with the principles of vibration measuring instruments
3. To acquaint with the practices of monitoring health conditions of the systems

Outcomes: Learner will be able to…

1. Develop mathematical model to represent dynamic system.
2. Estimate natural frequency of mechanical element / system.
3. Analyse vibratory response of mechanical element / system.
4. Estimate the parameters of vibration isolation system and
5. Control the vibrations to the acceptable level using basic vibration principles
6. Handle the vibration measuring instruments

Module	Details	Hrs.
1	**1.1 Basic Concepts of Vibration:** Introduction, classification, terminology, modelling vibration analysis **1.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by D'Alembert's Principle, Newton, Energy, Lagrangian and Rayleigh's method	**08**
2	**Multi Degree of Freedom System:** **2.1 Undamped free vibration:** Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems **2.2 Eigen Values and Eigen vectors:** for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	**10**
3	**Free Damped Single Degree of Freedom Vibration System:**Types of dampers, Viscous damped system- translatory and rotary systems, Coulomb's damping- final rest position of body in coulomb damping, motion with negative damping factor,	**06**
4	**4.1 Forced Single Degree of Freedom Vibratory System:**Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation **4.2 Vibration Isolation and Control:** Conventional Methods: By mass /Inertia, stiffness, damping (vibration isolation principles) Force Transmissibility, motion transmissibility, typical isolators & mounts. Introduction to Semi-Active and Active Vibration control.	**10**
5	**5.1 Vibration Measuring Instruments:**Principle of seismic instruments, vibrometer, accelerometer- undamped, damped **5.2 Introduction to Conditioning Monitoring and Fault Diagnosis:**Introduction to conditioning monitoring and fault diagnosis,Condition & Vibration Monitoring Techniques, Condition / vibration monitoring data collection. Signature analysis	**07**
6	**Non-Linear Vibration:**Basics of Non-linear vibration, systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase –plane technique, Duffing's equation, Jump phenomenon, Limit Cycle, Perturbation method.	**07**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
2. Mechanical Vibraitons by G. K. Grover
3. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
4. Vibration Analysis by P. Srineevasan, Tata McGraw Hill
5. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
6. Theory and Practice of Mechanical Vibrations by J.S.Rao, K. Gupta, New Age International Publications

7. Mechanical Vibrations by Den, Chambil, Hinckle
8. Mechanical Vibrations by J.P.Den Hartog, McGraw Hill Book Company Inc
9. Introduction to Dynamics and Control by Leonard Meirovitch, Wiley, New York
10. Elements of Vibration Analysis by Leonard Meirovitch, McGrmv- Hill, New York
11. Dynamics and Control of Strucdtures by Leonard Meirovitch, Wiley, New York
12. Matrices and Transformations by Antony J. Pettofrezzo, Dover, New York
13. Principles of Vibration by Benson H. Tongue, Oxford University Press
14. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
15. Vibrations by Balakumar Balachandan, Edward Magrab, Cengagae Learning

Course Code	Course/Subject Name	Credits
MEDLO7032	**AUTOMOBILE ENGINEERING**	**04**

Objectives:

1. To impart the understanding of important mechanical systems of an automobile
2. To provide insight into the electrical systems of an automobile
3. To familiarize with the latest technological developments in automotive technology

Outcomes: Learner will be able to…

1. Illustrate the types and working of clutch and transmission system.
2. Demonstrate the working of different types of final drives, steering gears and braking systems
3. Illustrate the constructional features of wheels, tyres and suspension systems
4. Demonstrate the understanding of types of storage, charging and starting systems
5. Identify the type of body and chassis of an automobile
6. Comprehend the different technological advances in automobile

Module	Details	Hrs
1	**Clutch :** Requirements of Clutches, Types of Clutches; Single Plate, Multi-plate, Wet Clutch, Semi-centrifugal, Centrifugal. Clutch materials. Clutch operating mechanisms; Mechanical, Electric, Hydraulic and Vacuum. Free Pedal Play. **Transmission:** Necessity of gear box. Sliding mesh, Constant mesh, and Synchromesh Gear selector mechanisms. Overdrives and hydrodynamic torque converter, Trouble shooting and remedies. **Propeller Shaft and Axle:** Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints Types of live axles; semi, three quarter and full floating axles Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine	**09**
2	**Final Drive and Differential :** Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and non-slip differential, Trouble shooting and remedies **Steering System :** Steering geometry, Steering requirements, Steering linkages and steering gears. Over steer and under steer, Cornering power, Reversibility of steering gears. **Braking System:** Requirement of brake, Classification of brakes, Brake Actuation Methods; Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake trouble shooting, Introduction to antilock braking system (ABS)	**08**
3	**Suspension System** Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types **Wheels and Tyres:** Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass	**07**
4	**Automotive Electrical System :** **Storage System:** Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline, ZEBRA, Sodium Sulphur and Swing batteries **Charging System:**	**06**

	Dynamo: Principle of operation, Construction and Working. Regulators, combined current and voltage regulator. Alternator: Principle of operation, Construction, Working. Rectification from AC to DC **Starting system:** Requirements, Various torque terms used, Starter motor drives; Bendix, Rubber compression, Compression Spring, Overrunning Clutch. Starter motor solenoids and switches	
5	**Body Engineering:** Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Chassis types and structure types: Open, Semi integral and integral bus structure Frames: functions and types of frames, Loads on frames, Load distribution of structure, Location of power plant	**06**
6	**Recent trends in Automobiles :** **Intelligent Vehicle Systems :** Cruise Control, Adaptive Cruise Control (ACC), Electronic Stability Program (ESP), Electronic Brake Distribution (EBD), Traction Control System (TCS). Integrated Starter Alternator (ISA)	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. The Automobile by Harbans Singh Reyat
3. The Automobile Engineering by T.R. Banga and Nathu Singh
4. Automotive Engineering Fundamentals by Richard Stone, Jeffrey K. Ball,SAE International
5. Vehicle body engineering by J Powlowski
6. Automobile Mechanics, N. K. Giri, 8thEdition, Khanna Publishers
7. Bosch Automotive Hand Book, 6thEdition, SAE Publications
8. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill
9. Motor vehicles by T. K. Garrett, K. Newton and W. Steeds
10. Automotive Mechanics by Joseph Heitner
11. Automobile Electrical and Electronics by Tom Denton
12. Automotive Electrical Equipment by P. L. Kohli
13. Computerised Engine Control by Dick H. King

Course Code	Course/Subject Name	Credits
MEDLO7033	**Pumps, Compressors and Fans**	**4**

Objectives

1. To study of Different types of Pumps, Compressors & Fans
2. To familiarise design aspects of Pumps, Compressors & Fans

Outcomes: Learner will be able to…

1. Select suitable Pump
2. Design a reciprocating pump and analyse its performance
3. Design a centrifugal pump and analyse its performance
4. Demonstrate basic principles of fans and blowers
5. Design fan/blower and analyse its performance
6. Design a compressor and analyse its performance

Module	Detailed Contents	Hrs.
01	**Introduction to Fluid Machinery:** Introduction to pumps, Introduction to blowers and compressors, Basic equations of energy transfer between fluid and rotor, Performance characteristics, Dimensionless parameters, Specific speed, stage velocity triangles, work and efficiency.	04
02	**Reciprocating Pumps and Centrifugal Pumps:** Introduction: Types, Component and Working of Reciprocating pump and Centrifugal Pumps, Discharge, Work done and power required to drive for single acting and double acting, Coefficient of discharge, slip, Effect of acceleration of piston on velocity and pressure, indicator diagram, Air Vessel, Operating characteristics.	06
03	**Design & Analysis of Pumps:** Design procedure and design optimization of Pumps, selection of pumps, Thermal design- Selection of materials for high temperature and corrosive fluids, Hydraulic design- Selection of impeller and casing dimension using industrial manuals	08
04	**Introduction to Fans, Blowers and Compressors:** Classification of blowers, Basics of stationary and moving air, Eulers characteristics, velocity triangles and operating pressure conditions, Equations for blowers, Losses and hydraulic efficiency, flow through impeller casing, inlet nozzle, Volute, diffusers, leakage, mechanical losses, surge and stall, Applications of blowers and fans **Compressors:** Basic theory, classification and application, Working with enthalpy-entropy diagram	06
05	**Design and Analysis of Fans and Blowers:** Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, Design procedure for selection and optimization of Blowers. Stage pressure rise, stage parameters and design parameters, Design of impeller and casing dimension in aerodynamic design	06
06	**Design & Analysis of Compressors:** Construction and approximate calculation of centrifugal compressors, impeller flow losses, slip factor, diffuser analysis, performance curves of centrifugal compressors, Basic design features of axial flow compressors; velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage of axial flow compressors	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Principles of Turbo machinery by Shepherd, D.G., Macmillan
2. Centrifugal Pump Design by John Tuzson, John Wiley
3. Blowers and Pumps by Stepanff, A.J., John Wiley and Sons Inc.
4. Centrifugal pumps and blowers by Austin H. Chruch, John Wiley and Sons
5. Centrifugal Pumps Design and Applications by Val S.Labanoff and Robert Ross, Jaico P House
6. Pump Hand Book by Igori Karassik, McGraw-Hill International Edition
7. Pumps by G.K.Sahu, New age international
8. Turbine, Compressors and Fans by S.M.Yahya, Tata Mc-Graw Hill Publishing Company
9. Fluid Mechanics and Hydraulic Machines by R. K. Bansal, Laxmi Publication
10. Gas Turbines by V. Ganeshan, Tata Mc-Graw Hill Publishing Company
11. Steam and Gas Turbine by R. Yadav,Central Publishing House, Allahabad

Course Code	Course/subject Name	Credits
MEDLO7034	**Computational Fluid Dynamics**	**4**

Objectives:

1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Outcomes: Learner will be able to…

1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discritisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyze the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection.	
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	
06	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Course Code	Course Name	Credits
ILO 7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life	05

	Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07

06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model’s optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel’s approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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4. Only **Four questions need to be solved**.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction ***1.1*** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.	09

	5.2 International relief aid agencies and their role in extreme events.	
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people’s participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	**04**
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
MEL701	**Machine Design –II**	**1**

Objectives:

1. To familiarise applications of strength design principles for various machine elements
2. To make conversant with preparation of working drawings

Outcomes: Learner will be able to…

1. Design gears based on the given conditions
2. Design gearbox for a given application
3. Design cam & followers for a given condition
4. Design clutches for a given application
5. Design brakes for given condition
6. Select bearings for a given applications from the manufacturers catalogue

Term Work: (Comprises aand b)

a)

1. **Term work -** Shall consist of design and detailed assembly drawing of minimum two design problems form the mentioned list (computer aided drawing on **A3 size sheets**):
    1. Design of Gears and gear box
    2. Design of cam and followers
    3. Design of clutches
    4. Design of brakes

2. **Course Project:** Students in a group of two to four will be able to design and prepare working drawings of any system having minimum 5 to 6 components by applying the knowledge gained during the course.

b) **Assignment :** Each assignment containing at least 2- numerical based on following topics. These design exercises should be in the form of design calculations with sketches and/ or drawings.

1. Rolling contact bearings
2. Sliding contact bearing
3. Design of belt, chain and flywheel

The distribution of marks for term work shall be as follows:

Exercises & Drawing sheets:	15 Marks
Course Project:	05 Marks
Attendance:	05 Marks

End Semester Practical/Oral examination:

1. Each student will be given a small task of design, based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task.
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL702	**CAD/CAM/CAE**	**01**

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to…

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects as well as store and manage data.
3. Create CAM Toolpath and prepare NC- G code
4. Apply rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises

1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work

Term work shall consist of

a. Any four exercises from 1 to 6 of above list
b. Part programming and part fabrication on CNC trainer
c. A course project in a group of not more than four students based on 8 and 9 of above list

The distribution of marks for term work shall be as follows:

- Exercises : 15 Marks
- Course Project : 05 Marks
- Attendance : 05 Marks

Assessment:

End Semester Practical/Oral Examination:

1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:
   Design Task: 15 marks
   Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL703	**Production Planning and Control**	**01**

Objectives:

1. To provide an exposure related to Production Planning & Control (PPC)
2. To give exposure to production scheduling and sequencing

Outcomes: Learner will be able to…

1. Prepare a process sheet
2. Prepare a Gantt Chart
3. Forecast the demand of the product and prepare an aggregate plan.
4. Perform ABC analysis of a given problem
5. Develop the skills of Inventory Management and cost effectiveness.
6. Create a logical approach to Line Balancing for various production systems.

Term Work

The Term work shall comprise of the following:
At least six laboratory exercises/assignments comprising questions/problems

Sr No	List of Laboratory Exercises (Any Six)
1	Preparation of a Process sheet of a simple turned/milled component
2	Numerical example on Johnson's Algorithm
3	An example on network crashing
4	Preparation of a Gantt Chart
5	A real life example on ABC analysis
6	An example on MRP for planned released orders
7	An example on line balancing
8	Preparation of organization charts with functional relationship for any SME.

Project Based Learning may be incorporated by judiciously reducing number of laboratory exercises

The distribution of marks for term work shall be as follows:

- Lab work/assignments/exercise : **20** marks
- Attendance : **05** marks

Practical/Oral examination

1. Each student will be given a small task based on laboratory excercises, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:
   Excercise: 15 marks
   Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEC801	**Design of Mechanical Systems**	**4**

Objectives:

1. To familiarise with the concept of system and methodology of system design
2. To study system design of various systems such as snatch block, belt conveyors, engine system, pumps and machine tool gearbox

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Design material handling systems such as hoisting mechanism of EOT crane,
3. Design belt conveyor systems
4. Design engine components such as cylinder, piston, connecting rod and crankshaft
5. Design pumps for the given applications
6. Prepare layout of machine tool gear box and select number of teeth on each gear

Module	Details	Hrs.
01	Methodology & Morphology of design, Optimum design, system concepts in design.	04
02	**Design of Hoisting mechanism:** Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	10
03	**Design of belt Conveyors-** Power requirement, selection of belt, design of tension take up unit, idler pulley	06
04	**Engine Design (Petrol and Diesel):** Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	10
05	**Design of Pump:** **5.1 Design of main components of gear pump.** 1 Motor selection 2 Gear design 3 Shaft design and bearing selection 4 Casing and bolt design 5 Suction and delivery pipe **5.2 Design of main components of Centrifugal Pump:** 1 Motor selection 2 Suction and Delivery pipe 3 Design of Impeller, Impeller shaft 4 Design of Volute Casing	10
06	**Design of Gear Box:** Design of gear boxes for machine tool applications(Maximum three stages and twelve speeds), Requirements of gear box, determination of variable speed range, graphical representation of speeds, structure diagram, ray diagram, selection of optimum ray diagram, estimation of numbers of teeth on gears, deviation diagram, layout of gear box	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Use of standard design data books like PSG Data Book, Machine Design Data Book- design of engine parts by Khandare S.S and Kale A.V. are permitted at the examination and shall be supplied by the college.

References:

1. Machine Design Exercises by S.N.Trikha, Khanna Publications, Delhi
2. Mechanical Engineering Design byShigley J E and Mischke C R, McGraw Hill
3. Mechanical design analysis byM FSpotts, Prentice Hall Inc
4. Design of Machine Elements, Bhandari VB, TMH
5. Machine Design by Black PH and O Eugene Adams, McGraw Hill
6. Design Data by P.S.G. College of Technology, Coimbatore.
7. I S: 2825 Code for unfired pressure vessels
8. Mechanical Design Synthesis with Optimisation Applications byJohnson R C, Von Nostrand-Reynold Pub
9. Engineering Design by Dieter G E, McGraw Hill Inc
10. Design of machine tools by S K Basu and D K Pal, Oxford and IBH Pub. Co.
11. Machine tool design by NKMehta, TMH
12. Mechanical System Design by SP Patil, JAICO students Ed., JAICO Publishing House
13. Material Handling Equipment by Rudenko, M.I.R. publishers, Moscow
14. Machine Design-An Integrated Approach by Robert L. Norton, Pearson Education
15. Material Handling Equipments by N. Rudenko, Peace Publication
16. Material Handling Equipments by Alexandrov, Mir Publication
17. Machine Desgin by Reshetov, Mir Publication
18. Machine Design by R.C.Patel, Pandya, Sikh, Vol -I & II, C. Jamnadas & Co
19. Design of Machine Elements by V. M. Faires
20. Pumps: Theory, Design and Applications by G K Sahu, New Age International
21. Gear Design Handbook by Gitin Maitra
22. Design Data Book- Design of engine parts by Khandare S.S & Kale A.V

Course Code	Course/Subject Name	Credits
MEC802	**Industrial Engineering and Management**	**04**

Objectives

1. To familiarise with concept of integration of various resources and the significance of optimizing them in manufacturing and allied Industries
2. To acquaint with various productivity enhancement techniques

Outcomes: Learner will be able to…

1. Illustrate the need for optimization of resources and its significance
2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in method study and understanding of work content in different situations.
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Modules	Detailed contents	Hrs.
01	**Introduction to Industrial Engineering** History and contribution, Industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach to industrial engineering, definition and concept of productivity, productivity measurements, factors influencing productivity and productivity improvement techniques.	06
	Value Engineering and Value Analysis: Distinction between value engineering & value analysis and their Significance. Steps in value engineering & analysis and Check lists.	**05**
03	**Work study:** Method study, micro-motion study and principles of motion economy, Work measurement: time study, work sampling, standard data, PMTS; MOST	**10**
04	**Work system design:** Introduction to ergonomics and its scope in relation to work. Outline of discipline of anatomy, physiology and psychology, with respect to ergonomics building blocks such as anthropometry and biomechanics Job evaluation, merit rating, incentive schemes, wage administration and business process reengineering	**08**
05	**Facility Design:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems Concepts of Group Technology and cellular manufacturing	**09**
06	**Agile manufacturing:**Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing, Lean Manufacturing, Value Stream Mapping	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Introduction to Work study, ILO, Geneva, and Oxford & IBH Pub Co. Pvt. Ltd.
2. Ergonomics at Work, Murrell
3. Plant Layout and Material Handling, James M. Apple, John Wiley & Sons
4. Facility Layout and Location – An Analytical Approach, Richard L. Francis& John A. White, Prentice Hall
5. Production Planning and Control, Samuel Elion
6. Production and Operations Management, Joseph G. Monks
7. Quality planning and analysis, J M Juran, FM Gryana, TMH
8. Total Quality Management, D. H. Bester Field et al. prentice hall
9. TQM in new product manufacturing, HG Menon; TMH
10. Industrial Engineering and Management by Dr Ravi Shankar

Course Code	Course Name	Credits
MEC803	**Power Engineering**	**4**

Objectives

1. To study boilers, boiler mountings and accessories
2. To study utilization of thermal and hydraulic energy
3. To study gas turbine and its applications

Outcomes: Learner will be able to…

1. Compute heat interactions in combustion of reactive mixtures
2. Differentiate boilers, boiler mountings and accessories
3. Calculate boiler efficiency and assess boiler performance
4. Demonstrare working cycles ofgas turbines
5. Draw velocity triangles of impulse/reaction turbines and calculate performance parameters/efficiency
6. Demonstrate basic working of pumps

Module	Detailed Contents	Hrs.
01	**Combustion of Reactive Mixtures** Combustion reactions, Stoichiometric A/F ratio, Actual A/F ratio, Heat of combustion, Enthalpy of formation, First law of reactive system, Adiabatic flame temperature.	04
02	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency	12
03	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio	05
04	**Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency, Afterburner, Introduction to Turbojet, Turbofan, Ram jet, Turboprop and Rocket engine	05
05	**Impact of Jets:** Impact of jet on flat and curved plates **Water Turbines:** Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Impulse Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:**Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters	12
06	**Pumps** Classification of pumps - positive displacement and non - positive displacement Positive Displacement pumps: Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. **Centrifugal Pumps**	10

	Types - radial flow, mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc., self-priming pumps, series and parallel operation of pumps, system curve for branch network, determination of operating point, Cavitation in pumps, Determination of available and required NPSH	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Thermal Engineering, R K. Rajput, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, Dhanpatrai & Sons
3. Steam and gas turbine, R Yadav.
4. Fluid Mechancis and Machinery, C P S Ojha, Chandramouli and R Berndtsson, Oxford University Press
5. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
6. Hydraulic Machinery, Jagdish Lal
7. Hydraulic Machines, R K Rajput, S.Chand Publication

Course Code	Course/Subject Name	Credits
MEDLO8041	**Power Plant Engineering**	**4**

Objectives

1. Study basic working principles of different power plants
2. Study power plant economics

Outcomes: Learner will be able to…

1. Comprehend various equipment/systems utilized in power plants
2. Demonstrate site selection methodology, construction and operation of Hydro Electric Power Plants
3. Discuss working, site selection, advantages, disadvantages of steam power plants
4. Discuss operation of Combined Cycle Power Plants
5. Discuss types of reactors, waste disposal issues in nuclear power plants
6. Illustrate power plant economics

Module	Detailed Contents	Hrs.
01	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants	06
02	Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants	10
03	Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator	08
04	Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles, Problems	08
05	Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors- PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled, Advantages and limitations, nuclear power station, waste disposal.	08
06	Power Plant Economics: Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing, Problems.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Power Plant Engineering, A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, New Age International Publishers
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. Power Plant Engineering, P.K. Nag, 2nd Edition, TMH, New Delhi
4. A Text Book of Power Plant Engineering, R.K. Rajput, Laxmi Publications
5. Hydro-Electric and Pumped Storage Plants, M G Jog, New Age International Publishers
6. A Course in Power Plant Engineering, Arora, Domkundwar, DhanpatRai & Co
7. Power Plant Engineering, P.C. Sharma, S.K. Kataria& Sons
8. Power Plant Engineering, G.R. Nagpal, Khanna Publishers
9. Power station Engineering and Economy by Bernhardt G.A. Skrotzki and William A. Vopat, TMH
10. Power Plant Engineering, Manoj Kumar Gupta, PHI Learning
11. Nuclear Power Plant Engineering, James Rust, Haralson Publishing Company
12. Nuclear Power Plants, Edited by Soon Heung Chang, InTech Publishers

Course Code	Course/Subject Name	Credits
MEDLO8042	**Rapid Prototyping**	**04**

Objectives

1. To familiarise with importance of Rapid Prototyping in Product Development.
2. To acquaint with the Synergic Integration Technologies

Outcomes: Learner will be able to…

1. Select the feasible RP process
2. Selct the feasible RP material
3. Gauge and Hybridize the ever-evolving Protoyping Technologies
4. Contribute towards the Product Development at the respective domain in the industry
5. Apply RP to build working prototypes
6. Demonstrate basics of virtual reality

Module	Detailed Contents	Hrs.
01	Introduction: Product Development Cycle and the product Life Cycle. Problems in Product Development and the use of Synergic Integration Technologies. Relationship between Product Development Cost and the Selling Price. Where does RP stand. Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, supported file formats and introduction to Solid Modelling.	10
02	Laminated Object Manufacturing (LOM), principle of operation, possible approaches, steps, advantages and limitations. Stadard Machine Specifications. Fused Deposition Modelling (FDM), principle of operation, process steps, advantages and limitations. Stadard Machine Specifications. Stereolithography Apparatus (SLA): Principle, process steps, advantages and limitations, Stadard Machine Specifications. Selective Laser Sintering (SLS): Principle, process steps, advantages and limitations, Stadard Machine Specifications.	12
03	Solid Ground Curing (SGC): Principle, process steps, advantages and limitations, PhotoMasking comparative with SLA and LOM ObJet: Principle, process steps, advantages and limitations, applications, Stadard Machine Specifications. 3D Printing: Principle, process steps, advantages and limitations, classification of printer family, Stadard Machine Specifications, DIY procedures.	12
04	Rapid Tooling: Need for metallic tooling, approaches, RP Processes for Tooling, Silicon Rubber Molding, Epoxy Tooling, Spray Metal Tooling, Cast Kirksite Tooling, 3D KelTool, QuickCast.	05
05	Materials for Rapid Prototyping Systems: Nature of material, types of material; polymers, metals, ceramics and composites, liquid based materials; photo polymer development, solid based materials; powder based materials.	05
06	Reverse Engineering: Introduction to Digitizing Methods; contact type and non-contact type, brief introduction to the types of medical imaging. Virtual reality: Definition, features of VR, Technologies used in VR, Introduction to Augmented reality.	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Rapid Prototyping, Principles and Applications byRafiq I. Noorani, Wiley & Sons
2. Rapid Prototyping: Principles and Applications byChua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific
3. Rapid Manufacturing – An Industrialrevolution for the digital age by N.Hopkinson, R.J. M. Hauge, P M, Dickens, Wiley
4. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping byIan Gibson, Wiley
5. Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography byPaul F.Jacobs, McGraw Hill
6. Rapid Manufacturing byPham D T and Dimov S S, Springer Verlog

Course Code	Course Name	Credits
MEDLO8043	**Renewable Energy Sources**	**4**

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study economics of harnessing energy from renewable energy sources

Outcomes: Learner will be able to…

1. Demonstrate need of different renewable energy sources
2. Discuss importance of renewable energy sources
3. Discuss various renewable energy sourses in Indian context
4. Calculate and analyse utilization of solar and wind energy
5. Illustrate design of biogas plant
6. Demonstrate basics of hydrogen energy

Module	Detailed Contents	Hrs.
01	**Introduction to Energy Sources**: Renewable and non-renewable energy sources, Need for Renewable Energy Sources, Energy Consumption as a measure of Nation's development; Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources, Present status and current installations, Introduction to Hybrid Energy Systems.	07
02	**Solar Energy**: Merits and demerits, Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length, Methods of Solar Radiation estimation. **Solar Energy collection devices and Classification:** Flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, Solar Photovoltaic systems & applications.	12
03	**Wind Energy**: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.	10
04	**Energy from Biomass**: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	06
05	**Geothermal Energy**: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India. **Energy from the ocean**: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy	08
06	**Hydrogen Energy:** Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Renewable Energy:Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, Oxford University Press
3. Solar Energy: Principles of Thermal Collection and Storage by SP Sukhatme and J K Nayak, TMH
4. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill.
5. Wind Power Technology, Joshua Earnest, PHI Learning, 2014
6. Renewable Energy Sources, J W Twidell& Anthony D. Weir. ELBS Pub.
7. Energy Conversion Systems, R D Begamudre, New Age International (P) Ltd., Publishers, New Delhi ,2000.
8. Solar Photovoltaics: Fundamentals, Technologies and Applications, C S Solanki, 2ndEdition, PHI Learning
9. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York
10. Wind and Solar Power Systems, Mukund R Patel, CRC Press
11. Wind Energy Explained: Theory, Design and Application, J F Manwell, J.C.McGowan, A.L.Rogers, John Wiley and Sons
12. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison

Course Code	Course Name	Credits
MEDLO8044	**Energy Management in Utility Systems**	**4**

Objectives:

1. To familiarise principles of energy management and concept of energy management in utility systems
2. To study energy economics and auditing
3. To study electrical energy management, cogeneration and waste heat recovery.

Outcomes: Learner will be able to…

1. Demonstrate general aspects of energy management
2. Summarize and explain need for energy management, economics and auditing
3. Illustrate basics of energy economics and financial analysis techniques
4. Describe importance of thermal and electrical utilitie's maintenance
5. Assess potential and summarise benefits of waste heat recovery and cogeneration
6. Illustrate waste heat recovery and cogeneration methods

Module	Detailed Contents	Hrs.
01	**General Aspects of Energy Management**: Introduction to utility systems (Types) Current energy scenario: India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency, Energy Conservation Act	08
02	**Energy Auditing :** Need of Energy Audit, Types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting, Energy audit software. Material & Energy Balance	08
03	**Energy Economics:** Costing of Utilities - Determination of cost of steam, natural gas, compressed air and electricity. Financial Analysis Techniques - Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis	09
04	**Energy Efficiency in Thermal Utilities:** Energy performance assessment and efficiency improvement of Boilers, Furnaces, Heat exchangers, Fans and blowers, pumps, Compressors and HVAC systems. Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system	08
05	**Electrical Energy Management and Lighting:** Distribution and transformer losses. Electrical motors - types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003. **Lighting** - Lamp types and their features, recommended illumination levels, lighting system energy efficiency.	07
06	**Cogeneration and Waste Heat Recovery**, Cogeneration- Need, applications, advantages, classification, the cogeneration design process. Waste heat recovery- Classification and application, Potential for waste-heat recovery in Industry, Commercial WHR devices, saving potential. CDM projects and carbon credit calculations	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Energy engineering and management, AmlanChakrabarti, PHI Learning, New Delhi 2012
2. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, 7thEdition,The Fairmont Press Inc
3. Energy management Handbook, Wayne C. Turner, 5thEdition,The Fairmont Press Inc., Georgia.
4. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI, New Delhi
5. Energy Performance assessment for equipment and Utility Systems Vol. 1 to 4, Bureau of Energy Efficiency, Govt. of India
6. General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, Govt of India
7. Boiler Operators Guide,4thEdition, Anthony L Kohan, McGraw Hill
8. Energy Hand book, Robert L. Loftness,2nd Edition, Von Nostrand Reinhold Company
9. Sustainable Energy Management, MirjanaGolusin, SinisaDodic, Stevan Popov, Academic Press
10. Energy Management, Trivedi P R, Jolka K R, Commonwelth Publications, New Delhi
11. www.enrgymanagertraining.com
12. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:**	6

	Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management,Gido Clements, Cengage Learning
4. Project Management,Gopalan, Wiley India
5. Project Management,Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning**	5

	• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached	**04**

	6.2 Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
   Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
MEL801	**Design of Mechanical Systems**	**1**

Objectives:

1. To familiarise with the concept of system and methodology of system design
2. To study system design of various systems such as snatch block, belt conveyors, engine system, pumps and machine tool gearbox
3. To familiarise with the standard codes of professional practices in designing the various systems

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Design of hoisting mechanism of EOT crane,
3. Design belt conveyor systems
4. Design pumps for the given applications
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design of machine tool gearbox

Term Work: Comprises a& b

a) Term work - Shall consist of

1. Design and detailed assembly drawing (computer aided drawing on **A3 size sheets)** of minimum two design problems, from the following:
    - i) Design of hoisting mechanisms
    - ii) Design of belt conveyors
    - iii) Design of pumps
2. **Course Project:**Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected.

b) Assignment: Exercises on following topics in the form of design calculations with sketches and / or drawings.

1. Engine design
2. Design of gearbox

The distribution of marks for term work shall be as follows:

- Exercises and Drawing sheets : 10 marks.
- Assignments : 05 marks
- Course Project : 05 marks.
- Attendance : 05 Marks.

Assessment:

End Semester Practical/Oral examination:

1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 802	**Power Engineering**	**01**

Objectives

1. To familiarisewith boilers, boiler mountings and accessories using models/cut sections
2. To familiarise with hydraulic energy conversion devices

Outcomes: Learner will be able to…

1. Differentiate boilers
2. Differentiate boiler mountings and accessories
3. Conduct a trial on impilse turbine and analyse its performance
4. Conduct a trail on reaction turbine and analyse its performance
5. Conduct a trial on Centrifugal pump and analyse its perfromance
6. Conduct a trial on Reciprocating pump and analyse its perfromance

List of Experiments

1. Demonstration of Boilers
2. Demonstration of Boiler mountings and accessories
3. Trial on Impulse turbine
5. Trial on Reaction turbine
6. Trial on centrifugal pump (Single stage/Multistage)
7. Trail on receprocating pump
8. Visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

Assessment:

Term Work

Term work shall consist of all the experiments from the list, 3 assignments containing numerical based on maximum contents of the syllabus and a visit report

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments): **10 marks**

Assignments: **05 marks**

Visit report**: 05 Marks**

Attendance: **05 marks**

End Semester Practical/Oral Examination:

1. Students in a group (4 to 6) have to perform trial either on Impulse turbine, Reaction turbine, Centrifugal Pump or Reciprocating Pump and the same will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Trial:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEP701/ MEP801	**Project (I and II)**	**03 + 06**

Objectives:
1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Outcomes: Learner will be able to…
1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Guidelines for Project

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor

Students should use multiple literatures and understand the problem.

Students should attempt solution to the problem by experimental/simulation methods.

The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points
1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points
1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.

Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai

Students should be motivated to publish a paper in Conferences/students competitions based on the work

AC 11.05.2017
Item No. 4.173

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Mechanical Engineering

Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17.

Co-ordinator, Faculty of Technology Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming sessions, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Mechanical Engineering. The Program Educational Objectives finalized for the undergraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for
B.E. in Mechanical Engineering
University of Mumbai
(With Effect from 2017-2018)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC301	Applied Mathematics III**	04	--	04	--	04
MEC302	Thermodynamics*	04	--	04	--	04
MEC303	Strength of Materials*	04	--	04	--	04
MEC304	Production Process I*	04	--	04	--	04
MEC305	Material Technology*	03	--	03	--	03
MEL301	Computer Aided Machine Drawing*	--	2[$]+4	--	03	03
MEL302	Strength of Material*	--	02	--	01	01
MEL303	Material Technology*	--	02	--	01	01
MEL304	Machine Shop Practice I*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC301	Applied Mathematics III**	20	20	20	80	03	--	--	100
MEC302	Thermodynamics*	20	20	20	80	03	--	--	100
MEC303	Strength of Materials*	20	20	20	80	03	--	--	100
MEC304	Production Process I*	20	20	20	80	03	--	--	100
MEC305	Material Technology*	20	20	20	80	03	--	--	100
MEL301	Computer Aided Machine Drawing*	--	--	--	--	--	50	50	100
MEL302	Strength of Material*	--	--	--	--	--	25	25	50
MEL303	Material Technology*	--	--	--	--	--	25	--	25
MEL304	Machine Shop Practice I*	--	--	--	--	--	50	--	50
Total				**100**	**400**		**150**	**75**	**725**

*** Common with Automobile Engineering**

**** Common with Automobile Engineering, Production Engineering and Civil Engineering**

[$] Theory for entire class to be conducted

Semester IV

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Pract**	**Theory**	**Pract**	**Total**
MEC401	Applied Mathematics IV**	04	--	04	--	04
MEC402	Fluid Mechanics*	04	--	04	--	04
MEC403	Industrial Electronics*	03	--	03	--	03
MEC404	Production Process II*	04	--	04	--	04
MEC405	Kinematics of Machinery*	04	--	04	--	04
MEL401	Data Base and Information Retrieval*	--	$2^{\$}+2$	--	02	02
MEL402	Fluid Mechanics*	--	02	--	01	01
MEL403	Industrial Electronics*	--	02	--	01	01
MEL404	Kinematics of Machinery*	--	02	--	01	01
MEL405	Machine Shop Practice II*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract/ Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam Duration (Hrs)**			
		Test1	**Test 2**	**Avg**					
MEC401	Applied Mathematics IV**	20	20	20	80	03	--	--	100
MEC402	Fluid Mechanics*	20	20	20	80	03	--	--	100
MEC403	Industrial Electronics*	20	20	20	80	03	--	--	100
MEC404	Production Process II*	20	20	20	80	03	--	--	100
MEC405	Kinematics of Machinery*	20	20	20	80	03	--	--	100
MEL401	Data Base and Information Retrieval*	--	--	--	--	--	50	50	100
MEL402	Fluid Mechanics*	--	--	--	--	--	25	25	50
MEL403	Industrial Electronics*	--	--	--	--	--	25	25	50
MEL404	Kinematics of Machinery*	--	--	--	--	--	25	--	25
MEL405	Machine Shop Practice II*	--	--	--	--	--	50	50	100
Total				**100**	**400**		**175**	**150**	**825**

*** Common with Automobile Engineering**

**** Common with Automobile Engineering, Production Engineering and Civil Engineering**

[$] **Theory for entire class to be conducted**

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC501	Internal Combustion Engines*	04	--	04	--	04
MEC502	Mechanical Measurements and Control*	04	--	04	--	04
MEC503	Heat Transfer*	04	--	04	--	04
MEC504	Dynamics of Machinery	04	--	04	--	04
MEDLO 501X	Department Level Optional Course I	04	--	04	--	04
MEL501	Internal Combustion Engines	--	02	--	01	01
MEL502	Mechanical Measurements and Control	--	02	--	01	01
MEL503	Heat Transfer	--	02	--	01	01
MEL504	Dynamics of Machinery	--	02	--	01	01
MEL505	Manufacturing Sciences Lab	--	02	--	01	01
MEL506	Business Communication and Ethics	--	02[$]+02	--	02	02
Total		**20**	**14**	**20**	**07**	**27**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC501	Internal Combustion Engines	20	20	20	80	03	--	--	100
MEC502	Mechanical Measurements and Control	20	20	20	80	03	--	--	100
MEC503	Heat Transfer	20	20	20	80	03	--	--	100
MEC504	Dynamics of Machinery	20	20	20	80	03	--	--	100
MEDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
MEL501	Internal Combustion Engines	--	--	--	--	--	25	25	50
MEL502	Mechanical Measurements and Control	--	--	--	--	--	25	25	50
MEL503	Heat Transfer	--	--	--	--	--	25	25	50
MEL504	Dynamics of Machinery	--	--	--	--	--	25	25	50
MEL505	Manufacturing Sciences Lab	--	--	--	--	--	25	--	25
MEL506	Business Communication and Ethics	--	--	--	--	--	50	--	50
Total				**100**	**400**		**175**	**100**	**775**

[$] Theory classes shall be conducted for entire class

Course Code	Department Level Elective Course I
MEDLO5011	Press Tool Design
MEDLO5012	Machining Sciences and Tool Design
MEDLO5013	Design of Jigs and Fixtures

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC601	Metrology and Quality engineering	04	--	04	--	04
MEC602	Machine Design I	04	--	04	--	04
MEC603	Finite Element analysis	04	--	04	--	04
MEC604	Refrigeration and Air Conditioning	04	--	04	--	04
MEDLO 602X	Department Level Optional Course II	04	--	04	--	04
MEL601	Metrology and Quality Engineering	--	02	--	01	01
MEL602	Machine Design I	--	02	--	01	01
MEL603	Finite Element Analysis	--	02	--	01	01
MEL604	Refrigeration and Air Conditioning	--	02	--	01	01
MEL605	Mechatronics Lab	--	02	--	01	01
Total		**20**	**10**	**20**	**05**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC601	Metrology and Quality engineering	20	20	20	80	03	--	--	100
MEC602	Machine Design I	20	20	20	80	03	--	--	100
MEC603	Finite Element Analysis	20	20	20	80	03	--	--	100
MEC604	Refrigeration and Air Conditioning	20	20	20	80	03	--	--	100
MEDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100
MEL601	Metrology and Quality engineering	--	--	--	--	--	25	25	50
MEL602	Machine Design I	--	--	--	--	--	25	--	25
MEL603	Finite Element analysis	--	--	--	--	--	25	25	50
MEL604	Refrigeration and Air Conditioning	--	--	--	--	--	25	25	50
MEL605	Mechatronics Lab	--	--	--	--	--	25	25	50
Total				**100**	**400**		**125**	**100**	**725**

Course Code	Department Level Optional Course II
MEDLO6021	Mechatronics
MEDLO6022	Robotics
MEDLO6023	Industrial Automation

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
MEC701	Machine Design II	04	--	04	--	04
MEC702	CAD/CAM/CAE	04	--	04	--	04
MEC703	Production Planning and Control	04	--	04	--	04
MEDLO 703X	Department Level Optional Course III	04	--	04	--	04
ILO701X	Institute Level Optional Course I#	03	--	03	--	03
MEL701	Machine Design II	--	02	--	01	01
MEL702	CAD/CAM/CAE	--	02	--	01	01
MEL703	Production Planning and Control	--	02	--	01	01
MEL704	Project I	--	06	--	03	03
Total		**19**	**12**	**19**	**06**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC701	Machine Design II	20	20	20	80	03	--	--	100
MEC702	CAD/CAM/CAE	20	20	20	80	03	--	--	100
MEC703	Production Planning and Control	20	20	20	80	03	--	--	100
MEDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I#	20	20	20	80	03	--	--	100
MEL701	Machine Design II	--	--	--	--	--	25	25	50
MEL702	CAD/CAM/CAE	--	--	--	--	--	25	25	50
MEL703	Production Planning and Control	--	--	--	--	--	25	25	50
MEP701	Project I	--	--	--	--	--	50	--	50
Total				**100**	**400**		**125**	**75**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
MEDLO7031	Mechanical Vibrations	ILO7011	Product Lifecycle Management
MEDLO7032	Automobile Engineering	ILO7012	Reliability Engineering
MEDLO7033	Pumps, Compressors and Fans	ILO7013	Management Information System
MEDLO7034	Computational Fluid Dynamics	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

# Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract**	**Theory**	**Pract**	**Total**
MEC801	Design of Mechanical Systems	04	--	04	--	04
MEC802	Industrial Engineering and Management	04	--	04	--	04
MEC803	Power Engineering	04	--	04	--	04
MEDLO 804X	Department Level Optional Course IV	04	--	04	--	04
ILO802X	Institute Level Optional Course II#	03	--	03	--	03
MEL801	Design of Mechanical Systems	--	02	--	01	01
MEL802	Power Engineering	--	02	--	01	01
MEP801	Project II	--	12	--	06	06
Total		**19**	**16**	**19**	**08**	**27**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC801	Design of Mechanical Systems	20	20	20	80	03	--	--	100
MEC802	Industrial Engineering and Management	20	20	20	80	03	--	--	100
MEC803	Power Engineering	20	20	20	80	03	--	--	100
MEDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II#	20	20	20	80	03	--	--	100
MEL801	Design of Mechanical Systems	--	--	--	--	--	25	25	50
MEL802	Power Engineering	--	--	--	--	--	25	25	50
MEL803	Project II	--	--	--	--	--	50	100	150
Total				**100**	**400**		**100**	**150**	**750**

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
MEDLO8041	Power Plant Engineering	ILO8021	Project Management
MEDLO8042	Rapid Prototyping	ILO8022	Finance Management
MEDLO8043	Renewable Energy Systems	ILO8023	Entrepreneurship Development and Management
MEDLO8044	Energy Management in Utility Systems	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

# Common with all branches

Course Code	Course Name	Credits
MEC301	**Applied Mathematics III****	**04**

Objectives

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyse engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex variables.

Outcomes: Learner will be able to…

1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

Module	Detailed Contents	Hrs
1	**Laplace Transform** 1.1 Function of bounded variation, Laplace Transform of standard functions such as 1, $t^n, e^{at}, \sin at, \cos at, \sinh at, \cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	**12**
2	**Complex variables:** 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions fo $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories **2.3** Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	**08**
3	**Complex Integration:** 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x)\, dx$	**08**
4	**Fourier Series:** 4.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period $2\pi \ \ and \ \ 2l$	**10**

	4.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parsvel's identities (without proof) 4.3 Complex form of Fourier series	
5	**Partial Differential Equations:** 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	**09**
6	**Correlation and curve fitting** 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Course Code	Course Name	Credits
MEC302	**Thermodynamics***	**04**

Objectives

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize application of the concepts of thermodynamics in vapour power, gas power cycles

Outcomes: Learner will be able to…

1. Demonstrate application of the laws of thermodynamics to wide range of systems.
2. Write steady flow energy equation for various flow and non-flow thermodynamic systems
3. Compute heat and work interactions in thermodynamics systems
4. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
5. Use steam table and mollier chart to compute thermodynamics interactions
6. Compute efficiencies of heat engines, power cycles etc.

Module	Detailed Contents	Hrs
01	**Basic Concepts & definitions:** Thermodynamics and its importance, Macroscopic and Microscopic view point, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Control Volume approach and Systems approach, Equilibrium – Thermal ,Chemical, Mechanical and thermodynamic, Pure Substance, Property – Intensive and Extensive, State, Path, Process and Cycle. Point Function and Path Function, Quasi Static Process and processes like Isobaric, Isochoric, Isothermal, Polytropic Process, Temperature and different scales, Zeroth Law of Thermodynamics, Energy, sources of energy; forms of energy, Energy transfer by work and forms of work ; free Expansion, Energy transfer by heat ; Adiabatic Process, Equations of state, Ideal gas Equation-; Specific gas constant and Universal Gas Constant	08
02	**First Law of Thermodynamics:** Relation between Heat and Work- Joules Constant, First law of thermodynamics for a cyclic process, First law of thermodynamics for a closed system undergoing a process, Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind, Application of first law of thermodynamics to closed system or Non flow Process, Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process – Joules Thompson Coefficient and its significance	07
03	**Second Law of Thermodynamics:** Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale **Entropy:** Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy	07
04	**Thermodynamic Relations:** Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius-Clapeyron Equation **Availability:**	10

	High grade and Low Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle, Decrease of Available Energy When heat is transferred through a finite temperature Difference, Second Law efficiency **Properties of Pure Substance:** Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart with suitable examples.	
05	**Compressors:** Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numerical), Theoretical and actual indicator diagram for multi stage compressors Rotary Air Compressors- Classification, Difference between compressors and blowers, Working and constructional details of roots blower, Screw type and vane type compressors	08
06	**Vapour Power cycle:** Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle. **Gas Power cycles:** Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Brayton Cycle, Sterling Cycle and Ericsson Cycle and Lenoir cycle and Atkinson cycle	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles,7th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers Engineering
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 5th edition, TMH
5. Thermodynamics by Onkar Singh, New Age International
6. Thermodynamics by C P Arora, TMH
7. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
8. Fundamentals of Thermodynamics by Moran & Shapiro
9. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., JohnWiley & Sons
10. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
11. Thermodynamics by J P Holman, McGraw-Hill & Co

Course Code	Course Name	Credits
MEC303	**Strength of Materials***	**04**

* Course common to Mechanical and Automobile Engineering

Objectives:

1. To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.
3. To study the effects of component dimensions, materials and shapes on stresses and deformations

Outcomes: Learner will be able to…

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the stresses induced in basic mechanical components.
4. Estimate the strain energy in mechanical elements.
5. Analyse the deflection in beams.
6. Analyse buckling and bending phenomenon in columns, struts and beams.

Module	**Detailed Contents**	**Hrs**
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, , Parallel Axis theorem, Polar moment of Inertia. **Stresses and Strains:** Definition – Stress, Strain, Hooke's law, elastic limit, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr's circle. **Elastic Constants:** Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk Modulus, yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading, deformation of tapering members, deformation due to self –weight, bars of varying sections, composite sections, thermal stress and strain.	12
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	08
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Flitched beams. **Direct and Bending Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	08
4	**Torsion:** Torsion of circular shafts- solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. **Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.	08

5	**Deflection of Beams:** Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings **Thin Cylindrical and Spherical Shells:** Cylinders and Spheres due to internal pressure, Cylindrical shell with hemi spherical ends	08
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2. Strength of Materials by Ryder, Macmillan
3. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
4. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
5. Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi
6. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
7. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
8. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
9. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
10. Introduction to Solid Mechanics by Shames, PHI
11. Strength of Materials by Nag and Chandra, Wiley India
12. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
13. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

Course Code	Course Name	Credits
MEC304	**Production Process***	**04**

Objectives

1. To study basic production processes.
2. To study how to select appropriate production processes for a specific application.
3. To study machine tools

Outcomes: Learner will be able to…

1. Demonstrate understanding of casting process
2. Illustrate principles of forming processes
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Distinguish between the conventional and modern machine tools.

Module	Detailed Contents	Hrs
1	1.1 **Metal casting:** Classification of Production Processes: Examples and field of applications Pattern materials and allowances, Types of pattern, Sand properties, Sand moulding, Machine moulding Gating system :Types of riser, types of gates, solidification Melting- cupola& induction furnaces 1.2 **Special casting processes** : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	**10**
2	2.1 **Joining processes:** Welding: Classification of welding, Oxy-acetylene welding, types of flames, equipment used, welding methods & applications, Arc welding principle and working of metal arc welding, TIG & MIG welding, submerged arc welding, electro-slag welding & stud welding PAM welding. Applications merits & demerits of above welding processes, fluxes used, Thermit welding, Resistance welding, Friction welding, ultrasonic, explosive, LASER, electron beam welding, Welding defects and remedies Soldering and brazing techniques & applications Fastening processes	**10**
3	3.1 **Forming processes:** Principles and process characteristics, Rolling types, Rolling parameters: Draught, spread, elongation, roll pressure, torque, work and power in rolling. Effect of front and back tension on rolling load and capacities, Rolling defects, Thread rolling roll forging, production of seamless tubes, Forging, Extrusion and Wire Drawing processes	**08**
4	4.1 **Moulding with polymers:** Moulding with polymers: Basic concepts related to Injection Moulding, Compression moulding, Transfer moulding, Blow Moulding, Rotational Moulding, Thermoforming and Extrusion. Applications of plastics in Engineering field 4.2 **Moulding with ceramics**: Blow moulding and extrusion of glass.	**06**
5	**Classification, Selection and application of Machine Tools:** 5.1 Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. 5.2 Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes	**10**
6	5.1 **Modern Machine Tools:** CNC machines: Introduction, principles of operation, Types – Vertical machining centres and horizontal machining centres, major elements, functions, applications, controllers, open loop and closed loop systems 5.2 Types of automatic machines, Transfer machines	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Workshop Technology By W. A. J. Chapman part I, II & III
2. A Textbook of Foundry Technology by M. Lal
3. Production Technology by R. C. Patel and C. G. Gupta Vol I, II.
4. Production Technology by Jain & Gupta
5. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R. Schmid, Prentice Hall
6. Production Technology by HMT
7. Elements of Workshop Technology Hazra Chaudhary Vol I, II.
8. Foundry technology by P.L. Jain
9. Production Technology by P.C. Sharma
10. Manufacturing processes by P. N. Rao, Vol. 1 and 2

Course Code	Course Name	Credits
MEC305	**Material Technology***	**03**

Objectives

1. To study basic engineering materials, their structure-property-performance
2. To study strengthening processes including heat treatment processes in order to enhance properties.
3. To study new materials and their applications

Outcomes: Learner will be able to…

1. Identify various crystal imperfections, deformation mechanisms, and strengthening mechanisms
2. Demonstrate understanding of various failure mechanisms of materials.
3. Interpret Iron-Iron carbide phase diagram, and different phases in microstructures of materials at different conditions.
4. Select appropriate heat treatment process for specific applications.
5. Identify effect of alloying elements on properties of steels
6. Illustrate basics of composite materials, Nano- materials and smart materials.

Module	Detailed Contents	Hrs
1	**1.1 Classification of Materials:** Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples **1.2 Lattice Imperfections:** Definition, classification and significance of Imperfections Point defects: vacancy, interstitial and impurity atom defects, Their formation and effects, Dislocation - Edge and screw dislocations Burger’s vector, Motion of dislocations and their significance, Surface defects - Grain boundary, sub-angle grain boundary and stacking faults, their significance, Generation of dislocation, Frank Reed source, conditions of multiplication and significance. **1.3 Deformation:** Definition, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping, Critical Resolved shear stress, Deformation in single crystal and polycrystalline materials, Slip systems and deformability of FCC, BCC and HCP lattice systems. **1.4 Strain Hardening:** Definition importance of strain hardening, Dislocation theory of strain hardening, Effect of strain hardening on engineering behaviour of materials, Recrystallization Annealing: stages of recrystallization annealing and factors affecting it	08
2	**Failure mechanisms:** **1.1 Fracture:** Definition and types of facture, Brittle fracture: Griffith’s theory of fracture, Orowan’s modification, Dislocation theory of fracture, Critical stress and crack propagation velocity for brittle fracture, Ductile fracture: Notch effect on fracture, Fracture toughness, Ductility transition, Definition and significance **1.2 Fatigue Failure:** Definition of fatigue and significance of cyclic stress, Mechanism of fatigue and theories of fatigue failure, Fatigue testing, Test data presentation and statistical evolution, S-N Curve and its interpretation, Influence of important factors on fatigue, Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue. **1.3 Creep:** Definition and significance of creep, Effect of temperature and creep on mechanical behaviours of materials, Creep testing and data presentation and analysis, Mechanism and types of creep, Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications, Creep Resistant materials	08
3	**3.1 Theory of Alloys& Alloys Diagrams :** Significance of alloying, Definition, Classification and properties of different types of alloys, Solidification of pure metal, Different types of phase diagrams (Isomorphous, Eutectic,	08

	Peritectic, Eutectoid, Peritectoid) and their analysis, Importance of Iron as engineering material, Allotropic forms of Iron, Influence of carbon in Iron- Carbon alloying Iron-Iron carbide diagram and its analysis, TTT diagram, CCT diagram Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons, their microstructures, properties and applications	
4	**4.1 Heat treatment Process:** Technology of heat treatment, Classification of heat treatment process, Annealing- Principle process, properties and applications of full annealing, Diffusion annealing, process annealing and Cyclic annealing, Normalizing, Hardening heat treatment, Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process, Surface hardening: Hardening and surface Hardening methods. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	**06**
5	**5.1 Effect of Alloying Elements in Steels**: Limitation of plain carbon steels, Significance of alloying elements,Effects of major and minor constituents, Effect of alloying elements on phase transformation Classification of tool steels and metallurgy of tool steels and stainless steel	**04**
6	**Introduction to New materials:** **6.1** Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications **6.2** Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites **6.3** An overview to Smart materials (e.g.: Rheological fluids)	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R.Balasubramaniam, Wiley India (P) Ltd
2. Material Science and Metallurgy by V.D. Kodgire, Everest Publishing House
3. Mechanical Behaviour of Materials by Courtney, McGraw Hill International New Delhi
4. Introduction of Engineering Materials, by B.K. Agrawal, McGraw Hill Pub. Co. ltd
5. Mechanical Metallurgy by G.E. Dieter, McGraw Hill International New Delhi
6. A text book of Metallurgy by A.R.Bailey, Macmillan & Co. Ltd., London
7. The Structure and Properties of Engineering Alloys by W.F. Smith, McGraw hill Int.
8. Engineering Physical Metallurgy, by Y. Lakhtin, Mir Publishers, Moscow
9. Introduction to Physical Metallurgy by SydneyAvner, McGraw Hill
10. Metallurgy for Engineers by E.C. Rollason - ELBS SOC and Edward Arnold, London

Course Code	Course Name	Credits
MEL301	**Computer Aided Machine Drawing***	**03**

Objectives:

1. To familiarise conversion of an object into a drawing
2. To study conventional representation of various machining and mechanical details as per IS
3. To become conversant with 2-D and 3-D drafting

Outcomes: Learner will be able to…

1. Visualize and prepare detail drawing of a given object.
2. Read and interpret the drawing
3. Draw details and assembly of different mechanical systems.
4. Convert detailed drawing into assembly drawing using modelling software
5. Convert assembly drawing into detailed drawing using modelling software
6. Prepare detailed drawing of any given physical object/machine element with actual measurements

Module	**Detailed Contents**	Theory	Practical
1	**1.1 Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc)	02	04
	1.2 Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components	01	--
	1.3 Solid Geometry: Intersection of surfaces and interpenetration of solids- Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views	04	--
2	**2.1 Geometric Dimensioning and Tolerancing (GD&T)** : Dimensioning with tolerances indicating various types of fits,	02	--
	2.2 Details and assembly drawing: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards,	02	--
	2.3 Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa,		
	2.4 Preparation of details and assembly drawings of *any three* from: Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures	02	08
	2.5 Cotter, Knuckle joint, Keys: keys-sunk, parallel woodruff, saddle, feather etc.	01	--
	2.6 Couplings: simple, muff, flanged Protected flange coupling, Oldham’s coupling, Universal coupling	02	06
3	**3.1 Preparation of details and assembly drawings of Bearings:** Simple, solid, Bushed bearing, I.S. conventional representation of ball and roller bearing, Pedestal bearing, footstep bearing	02	06
4	**4.1 Preparation of details and assembly drawings of pulleys, Pipe joints:** Classification of Pulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	06
	4.3 Pipe joints*(any two)*: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	--	06
5	**5.2 Preparation of details and assembly drawings of Valves, I.C. Engine parts:** Types of Valves, introduction to I.C. Engine	02	--
	5.3 Preparation of details and assembly drawings*(any three):* Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburettor, Fuel pump, injector, and Spark plug	--	08

6	**6.1 Reverse Engineering of a physical model**: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	02	06

Assessment:

Term work

A. Minimum two questions from theory part of each module should be solved as a home work in A-3 size sketch book.

B. A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module. Problems from practical parts of each module should be solved using any standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works, Inventor etc.

The distribution of marks for Term work shall be as follows:

• Home work sketch book	20 marks
• Printouts/Plots	20 marks
• Attendance	10 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is **three hours**, based on Part-B of the Term work, and should contain two sessions as follows:

Session-I: Preparation of 3-D models of parts, assembling parts and preparing views of assembly from given 2-D detailed drawing.

Session-II: Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.

Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.

2. Questions provided for practical examination should contain minimum five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:

- **Session-I** …… ….20 marks
- **Session-II** …… …20 marks
- **Oral** …… ……….10 marks

4. Evaluation of practical examination to be done based on the printout of students work

5. Students work along with evaluation report to be preserved till the next examination

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L. Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M. B. Shah
5. A text book of Machine Drawing by R. B. Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I.Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Course Code	Course Name	Credits
MEL302	**Strength of Materials***	**01**

Objectives:

1. To familiarise material behaviour under different loading conditions
2. To acquaint with surface hardness measurement method
3. To familiarise with impact test methods for different materials

Outcomes: Learner will be able to…

1. Analyse the stress - strain behaviour of materials
2. Measure ultimate tensile/compression strength of material
3. Measure torsional strength of material
4. Perform impact test using Izod and Charpy method
5. Measure the hardness of materials.
6. Perform flexural test with central and three point loading conditions

a) List of Experiments (Minimum Eight)

Module	**Detailed Contents**	**Laboratory Sessions**
1	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2 Hrs
2	Bending test on UTM	2 Hrs
3	Torsion test on mild steel bar / cast iron bar	2 Hrs
4	Impact test on metal specimen (Izod test)	2 Hrs
5	Impact test on metal specimen (Charpy test)	2 Hrs
6	Hardness test on metals - Brinell Hardness Number	2 Hrs
7	Hardness test on metals - Rockwell Hardness Number	2 Hrs
8	Flexural test on beam (central loading)	2 Hrs
9	Flexural test on beam (three point loading)	2 Hrs

b) Assignments: Atleast one problem on each of the following topics:

1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Strain energy and deflection.
5. Torsion, Columns and struts

Note: Preferably, the assignments shall be based on live problems.**Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term Work: Including Part a and b both

Distribution of marks for Term Work shall be as follows:

Part a	:	15marks.
Part b	:	05 Marks
Attendance	:	05 marks.

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
MEL303	**Materials Technology***	**03**

Objectives:

1. To familiarise with use of optical laboratory microscope
2. To acquaint with microstructures of ferrous (steel and cast iron) metals
3. To familiarise with microstructures of steel under different heat treated conditions
4. To study hardenability, fatigue test for fatigue strength and corrosion rate test

Outcomes: Learner will be able to…

1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography)
2. Interpret different phases present in different plain carbon steels and cast irons.
3. Perform different heat treatment processes for a steel and observe microstructures in these conditions
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel
5. Determine hardenability of steel using Jominy end Quench test
6. Determine S-N curve by Fatigue Test.

Sr No	Details
1	Study of metallurgical microscope
2	Metallographic sample preparation and etching
3	Microstructures of plain carbon steels
4	Microstructures of cast irons
5	Annealing, Normalizing and Hardening of medium carbon steel and observation of microstructures
6	Study of tempering characteristics of hardened steel
7	Determination of hardenability of steel using Jominy end Quench Test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

Assignments: Assignment on following topics

1. Crystal imperfections-deformation-strengthening mechanisms
2. Fracture-failure of metals
3. Iron –Iron carbide phase diagram/TTT diagram/CCT diagram.
4. Heat treatment processes
5. Alloy steels (e. g. alloy steels, tool steels)
6. New materials

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments**

Assessment:

Term Work: Including Laboratory Work and Assignments both

Distribution of marks for Term Work shall be as follows:

Laboratory work	15 marks
Assignments	05 Marks
Attendance	05 marks

Course Code	Course Name	Credits
MEL304	**Machine Shop Practice I***	**02**

Objectives:

1. To study basic machining processes.
2. To familiarise various machining operations and machine protocols

Outcomes: Learner will be able to…

1. Operate various machines like lathe, shaper etc.
2. Perform plain turning, taper turning, and screw cutting etc. on lathe machine.
3. Perform machining operations on shaper.
4. Demonstrate metal joining process like compressive welding.
5. Perform forging operations
6. Perform shaping operations

Module	**Details**	**Hrs**
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Taper Turning One job on Precision Turning, Taper Turning and Screw Cutting	**18**
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	**12**
3	Introduction to various forging tools Two jobs on Forging of Cutting Tools used on Lathe Machine	**12**
4	One simple exercise on Welding, Preparation of a component using Compressive Welding Joint	**6**

Assessment:

Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book	…….**40** marks
Attendance	…….**10** marks

Course Code	Course Name	Credits
MEC401	**Applied Mathematics IV****	**04**

Objectives:

1. To inculcate an ability to relate engineering problems to mathematical context
2. To provide a solid foundation in mathematical fundamentals required to solve engineering problem
3. To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
4. To prepare students for competitive exams

Outcomes: Learner will be able to…

1. Solve the system of linear equations using matrix algebra with its specific rules
2. Demonstrate basics of vector calculus
3. Apply the concept of probability distribution and sampling theory to engineering problems
4. Apply principles of vector calculus to the analysis of engineering problems
5. Identify, formulate and solve engineering problems
6. Illustrate basic theory of correlations and regression

Module	Details	Hrs
1	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) . Similarity of matrices. Functions of a square matrix	**08**
2	**Matrices:** 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors **Vector calculus** 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	**09**
3	**Vector calculus:** 3.1 Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem) **Linear Programming problems** 3.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	**09**
4	**Linear Programming problems Probability Distributions:** 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. **Probability Distributions** 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	**09**

5	**Sampling theory:** 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical 5.2. region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples 5.3. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. **5.4.** Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	**09**
6	**Sampling theory and ANOVA** 6.1. Chi-square test, Test for the Goodness of fit , Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Course Code	Course Name	Credits
MEC402	**Fluid Mechanics***	**04**

Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.

Outcomes: Learner will be able to…

1. Define properties of fluids and classification of fluids
2. Evaluate hydrostatic forces on various surfaces and predict stability of floating bodies
3. Formulate and solve equations of the control volume for fluid flow systems
4. Apply Bernoulli's equation to various flow measuring devices
5. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces
6. Apply fundamentals of compressible fluid flows to relevant systems

Module	**Detailed Contents**	**Hrs**
1	1.1Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids 1.2Fluid Statics: Definition of body and surface forces, Pascal's law, Basic hydrostatic equation, Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle	**06**
2	**2 Fluid Kinematics:** 2.1 Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two and three dimensional flows; Definition of control volume and control surface, Understanding of differential and integral methods of analysis 2.2 Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates, rotational and irrotational flows; Definition and equations for source, sink, irrotational vortex, circulation	**06**
3	**3 Fluid Dynamics:** 3.1 Integral equations for the control volume: Reynold's Transport theorem, equations for conservation of mass, energy and momentum, Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice and nozzle meters. 3.2 Differential equations for the control volume: Mass conservation in 2 and 3 dimension in rectangular, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation; Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes (Couette flow and plane Poiseuille flow)	**12**
4	**4 Real fluid flows:** 4.1 Definition of Reynold's number, Laminar flow through a pipe (Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows and theories of turbulence-Statistical theory, Eddy viscosity theory and Prandtl mixing length theory; velocity profiles for turbulent flows-universal velocity profile, 1/7th power law; Velocity profiles for smooth and rough pipes 4.2 Darcy's equation for head loss in pipe (no derivation),Moody's diagram, pipes in series and parallel, major and minor losses in pipes	**08**
5	**5 Boundary Layer Flows:** 5.1Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer,	**08**

	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies 5.2 Aerofoil theory: Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag	
6	**6 Compressible Fluid flow:** 6.1 Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity , momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio 6.2 Normal shocks, basic equations of normal shock, change of properties across normal shock	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press
3. Introduction to Fluid Mechanics by Fox and McDonald
4. Fluid Mechanics by R K Bansal
5. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
6. Fluid Mechanics by K. L. Kumar
7. Introduction to Fluid Mechanics by James A. Fay
8. Fluid Mechanics by B. M. Massey
9. Mechanics of Fluids by Irving Shames
10. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd

Course Code	Course Name	Credits
MEC 403	**Industrial Electronics***	**3**

Objectives

1 To study power electronic switches and circuits and their applications
2 To familiarise Op amp and digital circuits and their applications
3 To acquaint with basics of microprocessor and microcontroller
4 To study structure, working and characteristics of different types of industrial electric motors and their
5 selection for a particular application

Outcomes: Learner will be able to…

1 Illustrate construction, working principles and applications of power electronic switches
2 Identify rectifiers and inverters for dc and ac motor speed control
3 Develop circuits using OPAMP and timer IC555
4 Identify digital circuits for industrial applications
5 Illustrate the knowledge of basic functioning of microcontroller
6 Analyse speed-torque characteristics of electrical machines for speed control

Module	Detailed Contents	Hrs.
1	**Semiconductor Devices:** Diodes: Principles V-I characteristics and Application of: rectifier diode, zener diode, LED, photodiode, SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn-off thyristor (GTO). Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit. Characteristics and principle of Power BJT, power MOSFET, IGBT, comparison of devices, MOSFET/IGBT Gate driver circuit Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	08
2	**Phase controlled rectifiers and Bridge inverters**: Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Derivation of output voltage Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	07
3	**Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, Optical Isolation amplifier; 555 timer-Operating modes: monostable, astable multivibrator	04
4	**Digital logic and logic families:** Digital signals, combinational and sequential logic circuits, clock signals, Boolean algebra and logic gates. Integrated circuits and logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL logic family CMOS Logic family, comparison with TTL family Flip flops: Set Reset(SR),Trigger(T), clocked F/Fs; Registers, decoders and encoders, Multiplexer and Demultiplexer, applications	04
5	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller	08

	MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	
6	**Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Course Code	Course Name	Credits
MEC404	**Production Process II***	**04**

Objectives

1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To Acquaint tobasic principles of design of jigs and fixtures
3. To give exposure to Non-traditional machining operations.
4. To acquaint with fundamentals of metal cutting and tool engineering

Outcomes: Learner will be able to…

1. Demonstrate understanding of metal cutting principles and mechanism
2. Identify cutting tool geometry of single point and multipoint cutting tool
3. Demonstrate various concepts of sheet metal forming operations
4. Demonstrate concepts and use of jigs and fixtures
5. Illustrate various non-traditional machining techniques
6. Illustrate concepts and applications of additive manufacturing

Module	Details	Hrs
1	**Metal Cutting:** 1.1 Features of machining processes, concept of speed and cutting, mechanism of chip formation, concept of shear plane, chip reduction coefficient force analysis, Merchants circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles, Merchants theory-original and modified, effect of various parameters on cutting forces 1.2 Different types of dynamometers and their operations, Tool life definition, mechanism of tool wear and measurement, preliminary and ultimate feature, factors influencing tool life such as speed, feed, depth of cut, tool material, cutting fluids etc., Machinability, factors affecting surface finish	**16**
2.	**Tool Engineering**: 2.1 Cutting Tool geometry and definition of principles tool angles of single point cutting tools, Types of milling cutters and their geometry, Geometry of drill, broach 2.2 Specification & Selection of grinding wheel, dressing & truing and balancing of grinding wheels	**06**
3.	**Sheet Metal Forming**: 3.1 Sheet metal operations, Classification of presses, Types of Dies:, compound, combination, progressive, bending, forming and drawing dies, scrap strip layout, centre of pressure, selection of die sets, stock guides, strippers	**06**
4.	**Jigs and Fixtures**: 4.1 Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture	**06**
5.	**Non-traditional Machining:** 5.1 Ultrasonic Machining (USM), Abrasive Jet Machining (AJM),Water Jet Machining, Electrochemical Machining (ECM),Chemical Machining (CHM)Electrical Discharge Machining (EDM),Plasma Arc Machining (PAM),Laser Beam Machining (LBM),Electron Beam Machining (EBM)	**06**

6.	**Additive Manufacturing:** 6.1 Historical Development , Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping ,Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining, Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD, Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems 6.2 New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition 6.3 Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP).	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Tool Design by Donaldson
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R Schmid, Prentice Hall
5. Fundamentals of Tool Design by ASTME
6. Metal cutting Theory & Cutting Tool Designing by V. Arshinov, G Alekseev
7. Principle of Metal cutting by Sen & Bhattacharya
8. Manufacturing science by Ghosh and Mallick
9. Production Engg by P.C.Sharma
10. Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, , 2nd Edition, Springer 2015

Course Code	Course Name	Credits
MEC405	**Kinematics of Machinery***	**04**

Objectives:

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarise with various basic mechanisms and inversions
3. To study basics of power transmission

Outcomes: Learner will be able to…

1. Define various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Draw Cam profile for the specific follower motion
5. Analyse forces in various gears
6. Select appropriate power transmission for specific application

Module	Details	Hrs.
1	**1.1 Kinetics of Rigid Bodies:** Mass M.I. about centroidal axis and about any other axis, Radius of Gyration, D'Alembert's Principle of bodies under rotational motion about a fixed axis and plane motion, Application of motion of bars, cylinders and spheres only Kinetics of Rigid bodies: Work and Energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work Energy Principle and Conservation of energy **1.2 Basic Kinematics:** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	**10**
2	**2.1 Special Mechanisms:** **Straight line generating mechanisms:** Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's,Grasshopper mechanism, Tchebicheff's mechanisms **Offset slider crank mechanisms -** Pantograph, Hook-joint (single and double). **Steering Gear Mechanism -** Ackerman, Davis steering gears	**06**
3	**3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links):** Velocity analysis by instantaneous center of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) Analysis extended to find rubbing velocities at joints, mechanical advantage (Graphical approach) Velocity analysis of low degree complexity mechanism (Graphical approach), Auxiliary point method **3.2 Velocity and Acceleration Analysis of Mechanism:** Velocity and Acceleration- analysis by relative method (mechanism up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach)	**10**
4	**4.1 Cam Mechanism:** Cam and its Classification, Followers and its Classification, Motion analysis and plotting of displacement - time, velocity-time, acceleration-time, jerk-time graphs for uniform velocity, UARM, SHM, and Cycloid motions (combined motions during one stroke excluded), Motion analysis of simple cams - R-R cam, D-R-R and D-R-D-R Cam operating radial translating follower, Pressure angle	**06**

5	**5.1 Belts, Chains and Brakes**: **Belts**: Introduction, types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission **Chains:** types of chains, chordal action, variation in velocity ratio, length of chain **Brakes:** Introduction, types and working principles, Introduction to braking of vehicles	**06**
6	**6.1 Gears and Gear Trains:** **Gears-** Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik
2. Theory of Machines and Mechanism by Uicker Jr, Garden Pennock & J.F. Shigley, OXFORD University Press
3. Theory of Machines by P L Ballaney
4. Theory of Machines by S S Ratan
5. Kinematics of Machines by R T Hinckle, Prentice Hall Inc
6. Kinematics by V M Fairs, McGraw Hill
7. Mechanism Design: Analysis and Synthesis Vol I by A. Erdman and G N Sander, Prentice Hall
8. Kinematics and Dynamics of Planer mechanisms by Jeremy Hirsihham, McGraw Hill
9. Theory of Machines by W. G. Green, Bluckie & Sons Ltd

Course Code	Course Name	Credits
MEL401	**Data Base and Information Retrieval***	**02**

Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarise Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

Outcomes: Learner will be able to…

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

Module	Detailed Contents	Hrs.
01	**Introduction to Database Concept:** What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator	02
02	**Entity-Relationship Data Model:** Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	**Rational Model and Algebra:** Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	**Structured Query Language (SQL):** Overview of SQL, Data definition commands, set operations, aggregrate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	**Introduction to Transactions Management and Co-currency:** Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, **Co-currency Control:** Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	**Graphical User Interface:** Murphy's law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work **Visual Programming:** ***Sharing Data and Code:*** Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, usinf and creating ActiveX components, dynamics data exchange, Object linking and embedding, ***Creating visual software entities:*** Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces	06

Assessment:

Term Work:

Assign minimum two case studies for each student. On their case studies following exercises to be performed

1. Problem Definition and draw ER/EER diagram
2. Design Relational Model
3. Perform DDL operation
4. Perform DML and DCL operations
5. Design Forms using Visual programming
6. Retrieve the information through GUI.

Distribution of Term work Marks

Laboratory work	40 Marks
Attendance	10 Marks

End Semester Practical/Oral Examination:

1. Practical examination of 2 hours duration followed by viva to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks

Practical examination:	40 marks
Viva based on practical examination	10marks

4. Students work along with evaluation report to be preserved till the next examination

Reference Books:

1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Slberchatz, Sudarshan, 6thEdition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program, Deitel and Deitel,3rdEdition, Pearson Education
5. SQL and PL/SQL for Oracle 10g,Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India

Course Code	Course/Subject Name	Credits
MEL402	**Fluid Mechanics***	**1**

Objectives:

1. To study measurement as well as calibration principles
2. To practically verify the concepts learnt in theory course

Outcomes: Learner will be able to…

1. Calibrate different gauges
2. Measure hydrostatic forces
3. Verify the Archimedes Principle
4. Calibrate Venturimeter, Orificemeter and Pitot tube
5. Verify the Bernoulli's Principle
6. Read manometers and maintain them.

(a) List of Experiments: Any 6 experiments to be performed.

Expt no	Experiment	Hrs
1	Calibration of Pressure Gauges	**2**
2	Measurement of Hydrostatic Pressures	**2**
3	Verification of Archimedes' Principle	**2**
4	Calibration of Venturimeter/ Orificemeter/Nozzlemeter/ Pitot tube	**2**
5	Determine the friction factor for Pipes	**2**
6	Determination of major and minor losses in Pipe systems	**2**
7	Verification of Bernoulli's Equation	**2**
8	Experiment on Laminar flow in pipes	**2**
9	Calculation of Lift and Drag over an aerofoil	**2**
10	Determine the pressure profile over an aerofoil	**2**

(b) Mini Project: A mini project along with a brief report in which a group of students (maximum 4) will design/ fabricate/ assemble a unit or software based simulation to demonstrate any principle in Fluid Mechanics.

Assessment:

Term work Mark distribution will be as follows:

Laboratory work	15 marks
Mini Project	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL403	**Industrial Electronics***	**01**

Objectives
1. To study operational characteristics of various electrical and electronics components
2. To study microcontroller based applications and its programming

Outcomes: Learner will be able to…
1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different basic gates
4. Identify and use digital circuits for industrial applications
5. Built and demonstrate basic parameter measurement using microcontroller
6. Test and Analyse speed-torque characteristics of electrical machines for speed control.

List of Experiment: Minimum six from 1-9 and four from 10-15, in all minimum ten experiments need to be performed

Sr No	Detailed Contents
1	MOSFET / IGBT as a switch
2	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4	Full wave Rectifier using SCR
5	Single phase Bridge inverter with rectifier load
6	OPAMP as integrator
7	555 timer as astable multivibrator
8	Implementing study of gates and Logic Operations like, NOT, AND, OR
9	Realization of basic gates using universal gates
10	Light dimmer circuit using Diac-Triac
11	Speed control of DC motor
12	Speed control of induction motor
13	Simple programs using microcontroller
14	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
15	Microcontroller based speed control for Induction Motor

Learners (in a group) may be encouraged for Project Based Learning. Appropriate Weightage may be given in term work assessment

Assessment:

Distribution of marks for term work

Laboratory work	20 Marks
Attendance	05 Marks

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks

3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL 404	**Kinematics of Machinery***	**01**

Objectives:

1. To familiarise with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to…

1. Draw velocity diagram by instantaneous center method
2. Draw velocity and acceleration diagrams for four bar mechanism by relative method.
3. Draw velocity and acceleration diagrams for Slider crank mechanism by relative method
4. Draw Cam profile for the specific follower motion
5. Plot displacement-time, velocity-time, acceleration-time cam profiles
6. Develop and build mechanisms to provide specific motion

Term Work: (Comprises a and b)

a) List of Experiments

Sr No	**Details**	**Lab Session**
1	Analysis of velocity of mechanisms by Instantaneous Center of Rotation – 3 to 5 problems	2 Hrs
2	Analysis of velocity of mechanism by Relative method – 3 to 5 problems	4 Hrs
3	Analysis of Velocity & Acceleration of mechanism by Relative method – 3 to 5 problems	4 Hrs
4	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time and layout of cam profiles - 2 to 3 problems	4 Hrs
5	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	6 Hrs

b) Assignments: Minimum two problems on each of the following topics:

- **i)** Brakes
- **ii)** Chains and belts
- **iii)** Gear and gear trains

Distribution of marks for Term Work shall be as follows:

Laboratory work	:	15marks.
Assignments	:	05 Marks
Attendance	:	05 marks.

Course Code	Course/Subject Name	Credits
MEL405	**Machine Shop Practice – II***	**2**

Objectives:

1. To familiarise with basic machining processes.
2. To Acquaint to various machining operations and machine protocols

Outcomes: Learner should be able to ….

1. Operate lathe machine,
2. Perform shaping operations
3. Perform finishing operations on grinding machine
4. Perform milling operations.
5. Perform precision turning
6. Perform drilling and threading operations.

Module	Details	Hrs
1	One composite job consisting minimum four parts employing operations on lathe like precision turning screw cutting, boring etc. This job shall involve use of shaping, milling and grinding operations	**48**

Term Work:

1. Composite job mentioned above

2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book	……. 40 marks
Attendance	……. 10 marks

End Semester Practical Examination:

Pair of Internal and External Examiner should conduct practical/viva based on contents.
Practical examination will be held for 4 hours.
Job shall consist of minimum four operations such as precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.

Course Code	Course/Subject Name	Credits
MEC501	**Internal Combustion Engines***	**4**

Objectives

1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To acquaint with the various methods for measurement of engine performance
3. To provide insight into the harmful effects of engine pollutants and its control
4. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to…

1. Demonstrate the working of different systems and processes of S.I. engines
2. Demonstrate the working of different systems and processes of C.I. engines
3. Illustrate the working of lubrication, cooling and supercharging systems.
4. Analyse engine performance
5. Illustrate emission norms and emission control
6. Comprehend the different technological advances in engines and alternate fuels

Module	Detailed Contents	Hrs.
01	**Introduction** Classification of I.C. Engines; Parts of I.C. Engine and their materials, Cycle of operation in Four stroke and Two-stroke IC engines and their comparative study; Fuel air cycles and their analysis, Actual working cycle, Valve Timing Diagram. LHR Engines, Homogeneous charge compression Ignition,Rotary engine-Six stroke engine concept	06
02	**S.I. Engines** **Fuel Supply System:** Spark ignition Engine mixture requirements, Fuel-Air ratio, Simple carburettor and auxiliary circuits (excluding mathematical analysis of carburettors) Injection systems: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker **Combustion :** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers	12
03	**Compression Ignition Engines** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	10
04	**Engine lubrication:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers	06

05	**Engine Testing and Performance** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engine Effect of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric efficiencies, Heat balance sheet. **Engine Exhaust Emission and its control** Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	10
06	**Alternative Fuels** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engine, Mathur and Sharma
4. Internal Combustion Engines, Mohanty, Standard Book House
5. Internal Combustion Engine, Gills and Smith
6. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan, TMH
9. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
10. Internal Combustion Engine, S.L. Beohar
11. Internal Combustion Engine, P.M Heldt.
12. Internal Combustion Engines, V.L. Maleeve
13. Internal Combustion Engine, E.F. Oberi.
14. Internal Combustion Engine by Domkundwar

Course Code	Course/Subject Name	Credits
MEC502	**Mechanical Measurement and Control***	**4**

Objectives

1. To impart knowledge of architecture of the measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modelling of the control system
4. To acquaint with control system under different time domain

Outcomes: Learner will be able to…

1. Classify various types of static characteristics and types of errors occurring in the system.
2. Classify and select proper measuring instrument for linear and angular displacement
3. Classify and select proper measuring instrument for pressure and temperature measurement
4. Design mathematical model of system/process for standard input responses
5. Analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability

Module	Contents	Hours
01	1.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 1.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. 1.3 Errors in measurement: Types of errors, Effect of component errors, Probable errors.	**08**
02	2.1 **Displacement Measurement**: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) , Nozzle Flapper Transducer 2.2 **Strain Measurement**: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 2.3 **Measurement of Angular Velocity**: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. 2.4 **Acceleration Measurement:** theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers	**08**
03	**3.1 Pressure Measurement:** Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges **3.2 Flow Measurement**: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter **3.3 Temperature Measurement**: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers **3.4 Sensitivity analysis of sensor**-influence of component variation **3.5 Signal conditioning**: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation	**08**
04	**4.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **4.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	**06**
05	**5.1 Transient and steady state analysis of first and second order system.** Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	**06**

06	**Stability analysis** 6.1 Introduction to concepts of stability, The Routh criteria for stability 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots 6.3 State space modeling 6.4 Process control systems, ON-OFF control. P-I-D Control	**12**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition,*McGraw Hill*
2. Mechanical Engineering Measurements, A K Sawhney, *Dhanpat Rai& Sons, New Delhi*
3. Instrumentation & Mechanical Measurements, A K Thayal
4. Control System Engineering by Nagrath IJ and Gopal M, *Wiley EasternLtd.*
5. Modem Control engineering: by KOgata, *Prentice Hall*
6. Control systems by DhaneshManik, Cengage Learning
7. Engineering Metrology and Measurementsby N V Raghavendra and L Krishnamurthy, Oxford University Press
8. Instrumentation and Control System, W. Bolton, Elsevier
9. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
10. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
11. Mechanical Measurements by S P Venkateshan, Ane books, India

Course Code	Course/Subject Name	Credits
MEC 503	**Heat Transfer***	**04**

Objectives

1. To Study basic heat transfer concepts applicable for steady state and transient conditions
2. To Study mathematical modelling and designing concepts of heat exchangers

Outcomes: Learner will be able to…

1. Identify the three modes of heat transfer (conduction, convection and radiation).
2. Illustrate basic modes of heat transfer
3. Develop mathematical model for each mode of heat transfer
4. Develop mathematical model for transient heat transfer
5. Demonstrate and explain mechanism of boiling and condensation
6. Analyse different heat exchangers and quantify their performance

Module	Detailed Contents	Hrs.
01	**Basic concepts of heat transfer:** Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance	04
02	**Conduction:** Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, Heat conduction with heat generation in plane wall, solid cylinder and solid sphere, Critical radius of insulation in cylinder and sphere	08
03	**Heat transfer from Extended Surface:** Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well **Unsteady state heat transfer:** Applications of unsteady state heat transfer, Lumped system Analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts **Numerical methods in heat transfer:**Significance of numerical methods in heat transfer, Finite difference formulation of differential equations, One-dimensional heat conduction.	08
04	**Convection:**Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance **External Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature	10
05	**Radiation:**Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	08
06	**Boiling and Condensation:**Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation **Heat Exchangers:**Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers **Heat Pipe:** Introduction and application	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

ReferenceBooks:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2ndEdition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by FPIncropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy,2ndEdition, PEARSON
5. Heat Transfer by J P Holman, Mcgraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer byR K Rajput, S Chand and company

Course Code	Course/Subject Name	Credits
MEC504	**Dynamics of Machinery***	**4**

Objectives:

1. To acquaint with working principles and applications of Governors / Gyroscope
2. To study static and dynamic force analysis in the mechanisms
3. To familiarise with basics of mechanical vibrations
4. To study the balancing of mechanical systems

Outcomes: Learner will be able to…

1. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems
2. Illustrate basic of static and dynamic forces
3. Determine natural frequency of element/system
4. Determine vibration response of mechanical elements / systems
5. Design vibration isolation system for a specific application
6. Demonstrate basic concepts of balancing of forces and couples

Module	Details	Hrs.
1	**Governors and Gyroscopes:** 1.1 **Governors:** Introduction to Centrifugal and Inertia governors, Force analysis of governors- Porter and Hartnell governors, Performance characteristics of governors, Governors effort and power 1.2 **Gyroscope:** Introduction, Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization. Effect of gyroscopic and centrifugal couples, permissible speeds on curve paths, gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft.	**09**
2	2.1 **Static and Dynamic force analysis,** in slider crank mechanism (neglecting mass of connecting rod and crank), Engine force analysis, Turning moment on crank shaft 2.2 **Dynamically equivalent systems,** to convert rigid body in to two mass with and without correction couple	**06**
3	3.1 **Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters - springs, mass, damper, damper models, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis 3.2 **Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	**08**
4	4.1 **Free Damped Single Degree of Freedom Vibration System:** Viscous damped system - under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping 4.2 **Equivalent Single Degree of Freedom Vibration System:** Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system, Introduction to free multi-degree of freedom vibration systems	**07**
5	5.1 **Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) 5.2 **Vibration Isolation and Transmissibility:** Force Transmissibility, motion transmissibility, typical isolators & mounts.	**10**

	5.3 **Vibration Measuring instruments:** Principle of seismic instruments, vibrometer, accelerometer - undamped and damped, Introduction to conditioning monitoring and fault diagnosis	
6	6.1 **Rotor Dynamics:** Critical speed of single rotor, undamped and damped 6.2 **Balancing:** Static and Dynamic balancing of multi rotor system, balancing of reciprocating masses in In-line engines, V-engines (excluding other radial engines)	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
6. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
7. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
8. Mechanical Vibraitons by G.K.Grover
9. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
10. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
11. Vibration Analysis by P. Srineevasan, TMH
12. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
13. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
14. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York

Course Code	Course/Subject Name	Credits
MEDLO5011	**Press Tool Design**	**4**

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to….

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. Elaborate failure mechanisms of pressed components, safety aspects and automation in press working

Module	Contents	Hours
1	**Introduction to Press Working** – 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.	**08**
2	**Design and Calculations** of Piercing & Blanking Die– 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation) 2.2 Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools 2.3 Different types Die sets and its selection	**14**
3	3.1 **Selection of Material & Hardware –**Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools.	**03**
4	**Bending and Drawing-** 4.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies 4.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup 4.3 Defects in drawn as well as bent parts, Presses selection for drawing/forming operations 4.4 Basic construction and working of Bending and Drawing dies	**12**
5	5.1 **Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies,Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies	**05**
6	**Selection of Presses and its setting –** 6.1 Selection of Press and Press setting for Shearing, Bending, Progressive and Drawing dies, Equipment for Sheet metal operations (Basics only), Overloading of presses (load, energy considerations) 6.2 Introduction to Automation & Safety in Press shop	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Course Code	Course/Subject Name	Credits
MEDLO5012	**Machining Sciences And Tool Design**	**4**

Objectives

1. To familiarise with the basic concepts of machining science like mechanics of machining, tool wear, tool life and surface roughness.
2. To familiarise with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to…

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyse heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyse economics of machining operations

Module	Details	Hrs.
01	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model& modified model for orthogonal cutting, Lee and Shaffer model, Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry	**10**
02	2.1 **Temperatures in metal cutting and cutting fluids:** Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling	**06**
03	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	**06**

	geometrical contribution to roughness, edge finishing, residual stress and micro hardness	
04	4.1 **Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, Experimental methods to find Taylor exponents, Components of product cost,Optimum cutting velocity for minimum cost of production and maximum production rate	**06**
05	5.1 **Design of single point cutting tools** : Different systems of tool nomenclature like MRS, ORS and NRS, Interrelationship among different systems of nomenclature for tool angles, Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders	**08**
06	6.1 **Design of multi point cutting tools :** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application, Profile design of flat and circular form tools,Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow

Course Code	Course/Subject Name	Credits
MEDLO5013	**Design of Jigs and Fixtures**	**4**

Objectives

1. To acquaint with the concepts of planning and writing sequence of operations
2. To acquaint basics of identification and selection of location and clamping points on work-piece
3. To familiarise design principles in designing simple productive and cost effective jigs and fixtures

Outcomes: Learner will be able to…

1. Write methodically, the sequence of operations of simple work-piece
2. Identify and select locating and clamping points on work-piece
3. Demonstrate construction of drill jig
4. Illustrate construction of milling fixture
5. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
6. Design assembly of jigs and fixtures on simple work-piece

Module	Details	Hrs
01	1.1 **Introduction to Tool Design** Production Tooling's Jigs, Fixtures and their difference, their requirement(accuracy, machinability, quantity modifications so as to assist production, Interchange ability, Simplicity, Swarf disposal, Handling, Ease of operation, Skill reduction, Cost reduction), Analysis for Operation planning, sequencing of operations.	**08**
02	**Basic Construction of Jig & Fixture** 1.1 **Location & Locating Devices** Locating principles: Degrees of freedom, Redundant location, Fool-proofing, nesting, Locators: locators that control work piece on flat surfaces, location of cylindrical surfaces, conical locators, centralizers. 1.2 **Clamping & clamping Devices** Requirement of clamping system, Position of clamps, Types of clamps, Clamping devices; examples of typical clamps(multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices), Component distortion under clamping and cutting forces, Material used for different clamping devices of jigs/fixture and recommended hardness	**10**
03	3.1 **Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces /points, cutting tools and means of guiding and supporting Jigs, various types of Jig Bushes, Commonly used drill jigs, Case Study on Design of Drill Jig	**10**
04	4.1 **Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, tool setting block and Tennon's, Case Study on Design of Milling Fixture	**08**
05	5.1 **Introduction to Commonly used Fixtures** Turning Fixture (Chucks, collets, Mandrels) Grinding Fixture, Broaching Fixture, and Welding Fixture	**08**
06	6.1 **Indexing Jig & Fixture** Introduction, Application of indexing, Essential features of an indexing jig /fixture, Indexing Devices	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Jig and Fixture Design Manual, Erik K. Henrikson, Industrial Press
2. An introduction to jig and tool Design, MH A Kempster, 3rd Edition, ELBS
3. Jigs and Fixture, P. H. Joshi, TMH
4. Tool design, C. Donaldson, George H. Lecain, V.C. Goold, TMH
5. Jigs and Fixture Handbook, A.K. Goroshkin, Mir Publication
6. Jigs and Fixture, ASTME
7. Non- Standards Calming Devices, Hiran E. Grant TMH, New Delhi

Subject Code	Subject Name	Credits
MEL 501	**Internal Combustion Engines Lab**	**01**

Objectives:

1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to…

1. Dismantle engine assembly
2. Overhaul and Assemble engine components
3. Perform load test/speed test on engine setup
4. Calculate performance of multi cylinder engine
5. Analyse engine performance and draw heat balance sheet
6. Perform exhaust gas analysis

Part A: Dismantle, overhaul and assemble the following

1. 2 Stroke/ 4 Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

Part B: Performing experiments on engine test rigs

1. Morse Test on petrol engine
2. Speed Test on petrol or/and diesel engine
3. Load Test on diesel engine (engines)
4. Heat Balance test on diesel or petrol engines
5. Experimental determination of Air fuel ratio and volumetric efficiency of the engine
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines
7. Effect of Supercharging on Performance Characteristics of an engine

Term Work

Term work shall consist of minimum 6 exercises, from the list, out of which minimum 4 must be actual experiments from Part B and 1 case study/report (in group of not more than 3 students) on latest trends/developments in IC Engines.

The distribution of marks for term work shall be as follows:

1.	Laboratory work (Exercises) :	**15 marks**
2.	Case study:	**05 marks**
3.	Attendance:	**05 marks**

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEL 502	**Mechanical Measurement and Control**	**1**

Objectives
1. To study calibration of different measuring instruments
2. To study working of mechanical measurement system
3. To familiarise with different types of control systems

Outcomes: Learner will be able to…
1. Calibrate displacement sensors
2. Calibrate pressure and vacuum gauges
3. Measure torque using strain gauges
4. Identify system/process characteristics for standard input responses
5. Identify various types of control systems and time domain specifications
6. Analyse the problems associated with stability

List of Experiments

Sr. No.	Topic
1	Calibration of Displacement sensors like LVDT, Potentiometers etc.
2	Calibration of Pressure Gauges
3	Calibration of Vacuum Gauges
4	Torque measurement using strain gauges
5	Calibration of tachometers
6	Vibration Measurement & Calibration of Accelerometers.
7	Experiments on feedback control systems and servomechanisms
8	System Identification of any one of the sensor
9	Experiment on frequency response system identification
10	Experiment on transient state response of a control system.
11	Experiment on design of PID controller for a system.

(a) Design based experiments shall be encouraged using standard National Instrument/ texas instrument/ dSPACEGmbh/ Arduino or any other platform),**Learners (in a group) may be encouraged for Project Based Learning. Appropriate weightage may be given in term work assessment**

Term Work

Term work shall consist of minimum 8experiments (04 from the measurement group and 4 from the control group),

The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) **:** **15 marks**
- Design based experiment: **05 marks**
- Attendance**:** **05 marks**

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 503	**Heat Transfer Lab**	**01**

Objectives:

1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to…

1. Estimate thermal conductivity of metals/non metals/liquids
2. Compute heat transfer coefficient in natural as well forced convection
3. Measure emissivity of grey body
4. Quantify fin effectiveness/efficiency
5. Analyse heat exchanger performance
6. Demonstrate energy balance for heat exchanger

The laboratory experiments should be based on the following:

Expt.No	Name of Experiments	Time
1	**Conduction: (Any Two)** 1. Measurement of thermal conductivity of metal rod 2. Measurement of thermal conductivity of insulating material 3. Measurement of thermal conductivity of liquid 4. Determination of contact resistance 5. Effect of area on heat transfer	2Hrs
2	**Convection: (Any One)** 1. Measurement of heat transfer coefficient in natural convection 2. Measurement of heat transfer coefficient in forced convection 3. Comparison of heat transfer coefficient of free and forced convection	2Hrs
3	**Radiation: (Any One)** 1. Verification of Stefan Boltzmann Law 2. Measurement of Emissivity of Grey surface	2Hrs
4	**Transient Conduction:** 1. Unsteady state heat transfer in cylinder/rod/wall	2Hrs
5	**Fins: (Any One)** 1. Determination of fin efficiency and fin effectiveness 2. Comparison of fin performance of Various type of fins	2Hrs
6.	**Boiling and Condensation: (Any One)** 1. Measurement of heat transfer coefficient in boiling process of water. 2. Measurement of heat transfer coefficient in condensation of saturated steam.	2Hrs
7	**Heat Exchangers: (Any One)** 1. Estimation of overall heat transfer coefficient and effectivenessof double pipe heat exchanger (parallel flow and Counter flow arrangement) 2. Estimation of overall heat transfer coefficient and effectivenessof shell and tube heat exchanger (parallel flow and Counter flow arrangement) 3. Estimation of overall heat transfer coefficient and effectiveness of plate type heat exchanger.	2Hrs

Assignments: Assignment consisting of at least 3 numerical on each of the following topics

1. Steady state conduction
2. Fins and unsteady state conduction
3. Convection and dimensional analysis

4. Radiation
5. Heat Exchangers

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term work Mark distribution will be as follows:

Laboratory work	15 marks
Assignments	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL504	**Dynamics of Machinery***	**1**

Objectives:

1. To acquaint with working principles and applications of gyroscope and governors
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to…

1. Plot and analyse governor characteristics
2. Analyse gyroscopic effect on laboratory model
3. Estimate natural frequency of mechanical systems
4. Analyse vibration response of mechanical systems
5. Determine damping coefficient of a system
6. Balance rotating mass

Term Work: (Comprises part a and b)

a) List of Experiments: (Minimum Eight)

Sr. No.	**Title of Experiment**	**Laboratory Sessions**
1	Experiments on Governors- Porter Governor, Hartnell Governor	2 hrs
2	Experiments on Gyroscope	2 hrs
3	Determine natural frequency of compoundpendulum, equivalent simple pendulum system.	2 Hrs.
4	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel	2 Hrs
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	2 Hrs
6	Experimenton whirling of shaft	2 Hrs
7	Determination of damping coefficient of any system/media	2 Hrs
8	Experimental balancing of single and multi-rotor system	2 Hrs
9	Measurement of vibration response of a system	2 Hrs
10	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2 Hrs

b) Assignment: Minimum two problems on each of the following topics:

1. Governors and Gyroscope
2. Static and dynamic force analysis
3. Vibration, isolation and control
4. Vibration measuring instruments
5. Rotor dynamics

Project Based Learning may be incorporated by judiciously reducing number of assignments

Term Work

The distribution of marks for term work shall be as follows:

- Laboratory work : 15 marks.
- Assignments : 05 marks.
- Attendance : 05 Marks.

Course Code	Course/Subject Name	Credits
MEL 505	**Manufacturing Sciences Lab**	**1**

Objectives:

1. To study conventional machining operations
2. To familiarise with CNC machining operation
3. To acquaint with Non Traditional machining operations

Outcomes: Learner will be able to…

1. Estimate machining time for simple and taper turning operations on lathe
2. Estimate machining time for threading/knurling operations on lathe
3. Estimate machining time for various machining operations on shaper
4. Perform NC, CNC and DNC machining operations
5. Write CNC program for different operations
6. Identify machining parameters for various Non Traditional machining operations

Sr No.	Details
1	Introduction to machining operations
2	Introduction to lathe machine (other than plain turning operation) and shaping machine
3	Machining and machining time estimation for taper turning
4	Machining and machining time estimation for thread cutting
5	Machining and machining time estimation for internal thread cutting
6	Machining and machining time estimation for knurling
7	Machining and machining time estimation for eccentric turning
8	Machining of hexagon and square in shaping machine
9	NC, CNC, DNC machining operations
10	CNC programming for Turning and Drilling operations
11	Different Non Traditional machining operations with process parameters

Term Work:

All the assignments mentioned above with relevant sketches.

Distribution of marks for Term work shall be as follows:

All the above listed assignments:	**20 marks**
Attendance:	**05 marks**

Subject Code	Subject Name	Credits
MEL506	**Business Communication & Ethics**	**02**

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Outcomes: Learner will be able to…

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	**Detailed Contents**	**Hrs.**
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	**Employment Skills**	**07**
6.1	Group Discussion	

6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

Assessment:

List of Assignments

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list.

The distribution of marks for term work shall be as follows:

Book Report	**10 marks**
Assignments:	**10 marks**
Project Report Presentation:	**15 marks**
Group Discussion:	**10 marks**
Attendance:	**05 marks**

References:

1. Fred Luthans, “Organizational Behavior”, Mc Graw Hill,
2. Lesiker and Petit, “Report Writing for Business*”*, Mc Graw Hill
3. R.Subramaniam, “Professional Ethics” Oxford University Press
4. Huckin and Olsen, “Technical Writing and Professional Communication”, McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, “Personal Development for Life and Work”, Thomson Learning, 12th Edition
7. Heta Murphy, “*Effective Business Communication”* , Mc Graw Hill, edition
8. R.C Sharma and Krishna Mohan, “*Business Correspondence and Report Writing”,*
9. Raman Sharma, *Communication Skills*, Oxford University Press
10. B N Ghosh, “*Managing Soft Skills for Personality Development*”, Tata McGraw Hill Lehman,
11. Dufrene, Sinha, “*BCOM*”, Cengage Learning, 2nd edition
12. Bell . Smith, “Management Communication” Wiley India Edition, 3rd edition.
13. Dr. K. Alex ,”Soft Skills”, S Chand and Company
14. Robbins Stephens P., “Organizational Behavior”, Pearson Education
15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course/Subject Name	Credits
MEC 601	**Metrology and Quality Engineering**	**4**

Objectives:

1. To acquaint with measuring equipment used for linear and angular measurements.
2. To familiarize with different classes of measuring instruments and scope of measurement in industry and research
3. To acquaint with operations of precision measurement, instrument/equipment for measurement
4. To inculcate the fundamentals of quality concepts and statistics in metrology

Outcomes: Learner will be able to…

1. Demonstrate inspection methods and different gauges
2. Illustrate working principle of measuring instruments and calibration methodology
3. Illustrate basic concepts and statistical methods in quality control
4. Demonstrate characteristics of screw threads, gear profile, and tool profile
5. Illustrate the different sampling techniques in quality control
6. Illustrate different nondestructive techniques used for quality evaluation

Module	Details	Hours
1	1.1 **Introduction to Metrology:** Fundamental Definitions, Types of Standards, Precision and Accuracy, Measurement Errors, linear measurements by Vernier calliper, micrometer, slip gauges, Angular Measurement: Universal bevel protractor, clinometers, sine bar, angle gaugescase studies on Industrial and Research Applications and Scope 1.2 **Introduction to Nano-Metrology**	06
2	1.3 **Design of Gauges :** Limits, Fits, Tolerances, Types of Gauges, Taylor’s Principle of Limit Gauges, IS 919 for design of gauges 1.4 **Comparators :** Definition, Classification, Working principle of Mechanical, Opto-mechanical, Pneumatic and Electrical/Electronic comparators with advantages, limitations and uses 1.5 **Surface Texture measurement:** Surface roughness, Waviness, Roughness Parameter Ra, Rz, RMS etc., working of Tomlinson surface meter, Taly-surf surface roughness tester, Surface roughness symbols 1.6 **Flatness Test measurement by Interference principle:** Concept of Flatness, Interferometer principle for measurement, Optical Flats – study of Surface textures under monochromatic light source, fingertip test technique	14
3	3.1 **Screw Thread Measurement :** Screw threads Terminology, screw thread errors, Effective diameter measurement of screw thread by Floating Carriage micrometer 3.2 **Gear Measurement :** Gear Terminology, Gear errors, Measurement by Parkinson Gear tester and Gear tooth Vernier Calliper 3.3 **Special Measuring Instruments :** Measurement by Tool Maker’s Microscope, Optical Profile Projector, CMM and Autocollimator	12

4	4.1 **Quality Engineering** Introduction to Quality, Classification of Quality Tools, Quality of Design, Quality of Conformance, Compromise between Quality and Cost, Introduction to Six Sigma 4.2 **SQC & SQC tools** Statistics in Quality control, Variables and Attributes data, Process Capability, Control charts for variables and for attribute data($\bar{X}$and R-Chart, p-chart np-chart, c-chart, U-chart), Applications of SQC in engineering – case studies	08
5	5.1 **Sampling Techniques** Advantages of Sampling Inspection, operating characteristic (OC) curve. Choosing OC curve for appropriate sampling plan, acceptance sampling 5.2 **Role of computers in metrology**	04
6	6.1 **Non-destructive Testing** Visual, Dye Penetrant, Magnetic Particle, X ray Radiography, Ultrasonic Testing, Eddy Current testing methods.	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Engineering Metrology,K.J. Hume, Kalyani Publications
2. Mechanical Measurements and Metrology by RKJain, Khanna Publishers
3. A text book of Engineering Metrology by IC Gupta, DhanpatRai Publications
4. Metrology and Measurement by Anand,Bewoor and VinayKulkarni, McGraw Hill
5. Engineering Metrology and Measurement by N V Raghavendra and Krishnamurthy, Oxford University Press
6. Engineering Metrology and Measurements, Bentley, Pearson Education
7. Statistical Quality Control by AL Grant, McGraw Hill, New York
8. Statistical Quality Control by R C Gupta, Khanna Publishers
9. Juran on Planning for Quality,Juran J M,TheFree Press, 1988.
10. Statistical Quality Control by M Mahajan, Dhanpat Rai and Sons

Course Code	Course Name	Credits
MEC602	**MACHINE DESIGN – I***	**4**

Objective:

1. To study basic principles of machine design
2. To acquaint with the concepts of design based on strength & rigidity
3. To familiarize with use of design data books & various codes of practice
4. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations
2. Illustrate basic principles of machine design
3. Design machine elements for static as well as dynamic loading
4. Design machine elements on the basis of strength/ rigidity concepts
5. Use design data books in designing various components
6. Acquire skill in preparing production drawings pertaining to various designs

Modules	Details	Hrs.
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers	06
2	**Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. **Thick Cylinders:** Design of thick cylinders subjected to an internal pressure using Lame's equation	06
3	**Design against static loads:**Cotter joint, Knuckle joint, Turn buckle, Bolted and welded joints under eccentric loading;Power Screw – screw presses, C-clamps along with the Frame, Screw Jack	12
4	**Design against fluctuating loads:** variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses	06
5	**Design of Shaft:** power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria **Keys**: Types of Keys and their selection based on shafting condition **Couplings:** Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	11
6	**Design of Springs:** Helical compression, Tension Springs under Static and Variable loads, Leaf springs	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

Course Code	Course Name	Credits
MEC603	**Finite Element Analysis**	**4**

Objectives:

1. To familiarise with concepts of FEM
2. To study the applicability of FEM to engineering problems
3. To acquaint with application of numerical techniques for solving problems

Outcomes: Learner will be able to…

1. Solve differential equations using weighted residual methods
2. Develop the finite element equations to model engineering problems governed by second order differential equations
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system
6. Use commercial FEA software, to solve problems related to mechanical engineering

Module	Details	Hrs.
01	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing equations, Differential equations in different fields 1.3 Approximate solution of differential equations, Weighted residual techniques, Boundary value problems	**08**
02	**FEA Procedure:** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the, Finite Element Method 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', transformation and assembly concepts	**08**
03	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams 3.4 Solution of one dimensional structural and thermal problems using FE Software, Selection of suitable element type, modelling, meshing, boundary condition, convergence of solution, result analysis, case studies	**10**
04	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element, four node quadrilateral element, eight node quadrilateral element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange’s methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoparametric, super parametric elements, Compatibility, Patch test, Convergence criterion, sources of errors	**08**

05	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axisymmetric problems 5.2 Jacobian matrix, stress analysis of CST and four node Quadratic element	**08**
06	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Text book of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by JNReddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu,Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John-Wiley Sons
7. The Finite Element Method in Engineering by SSRao, Butter WorthHeinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Course Code	Course/Subject Name	Credits
MEC604	**Refrigeration and Air Conditioning**	**4**

Objectives

1. To study working and operating principles of Air Refrigeration, Vapour Compression and Vapour Absorption system
2. To study components of refrigeration and air conditioning systems
3. To study controls and applications of refrigeration and air conditioning

Outcomes: Learner will be able to…

1. Demonstrate fundamental principles of refrigeration and air conditioning
2. Identify and locate various important components of the refrigeration and air conditioning system
3. Illustrate various refrigeration and air conditioning processes using psychometric chart
4. Design Air Conditioning system using cooling load calculations.
5. Estimate air conditioning system parameters
6. Demonstrate understanding of duct design concepts

Module	Detailed Contents	Hrs.
01	**Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Co- efficient of Performance, Energy Efficiency Ratio (EER), and BEE star rating Air refrigeration systems: Bell Coleman cycle, applications Aircraft air refrigeration systems: Need for aircraft refrigeration, Simple, Bootstrap including evaporative cooling, Reduced ambient, Regenerative air cooling system, Comparison of these systems based on DART rating.	08
02	**Vapour Compression Refrigeration System**: Simple vapour compression cycle, Effect of liquid sub cooling& superheating, effect of evaporator and condenser pressures, methods of subcooling, use of P-h charts, Actual VCR cycle, Use of P-h Charts, Comparison between air-cooled and water-cooled condenser based air conditioning systems, Types of condensers, evaporators, expansion devices and Compressors **Cooling tower:** Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance **Refrigerants**: Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties, Secondary refrigerants, ODP and GWP, Montreal protocol and India's commitment, Recent substitutes for refrigerants	12
03	**Other Refrigeration Systems**: Vapour Absorption Refrigeration, Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system, **Non-Conventional Refrigeration Systems:** Thermoelectric Refrigeration, Thermo-acoustic Refrigeration, Vortex Tube Refrigeration	06
04	**Psychrometry:** Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning	05
05	**Design of Air Conditioning Systems**: Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality, Green Buildings	12

	Duct Design Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating	
06	**Controls and Applications**: Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation ,Freeze Drying, A/c in textile ,printing pharmaceutical industry and Hospitals , Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1 Refrigeration and air-conditioning – C P Arora, TMH
2 Principles of refrigeration – R J Dossat, Willey Eastern Publication
3 Refrigeration and air-conditioning – W F Stoeker and J W Jones, TMH
4 Modern Air-conditioning practice – C P Arora, TMH
5 Refrigeration and air-conditioning- Manohar Prasad, New Age Int (P) Ltd
6 Basic Refrigeration and air-conditioning- P.Ananthanarayana, TMH
7 ASHRAE Handbook of Fundamentals
8 ASHRAE Handbook of Systems
9 ASHRAE Handbook of Equipment
10 ISHRAE Air Conditioning Handbook
11 ISHRAE Refrigeration Handbook

Course Code	Course Name	Credits
MEDLO6021	**Mechatronics**	**4**

Objectives

1. To study key elements of Mechatronics system and its integration
2. To familiarise concepts of sensors characterization and its interfacing with microcontrollers
3. To acquaint with concepts of actuators and its interfacing with microcontrollers
4. To study continuous control logics i.e. P, PI, PD and PID
5. To study discrete control logics in PLC systems and its industrial applications

Outcomes: Learner will be able to…

1. Identify the suitable sensor and actuator for a mechatronics system
2. Select suitable logic controls
3. Analyse continuous control logics for standard input conditions
4. Develop ladder logic programming
5. Design hydraulic/pneumatic circuits
6. Design a mechatronic system

Module	Detailed Contents	Hrs.
1	**Introduction of Mechatronics and its block diagram representation** Key elements of mechatronics, Applications of Mechatronics domestic, industrial etc. Representation of mechatronic system in block diagram and concept of transfer function for each element of mechatronic system, Reduction methods and its numerical treatment for represented block diagram	08
2	**Selection of Sensors & Actuators** Sensors: Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
3	**Data Acquisition, Signal Conditioning & Microcontroller System Theory:** Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Convertor) Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Convertor) R-2R circuit and DAC resolution Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	08
4	**Pneumatics and hydraulics:** Hydraulic and pneumatic devices: Different types of valves, Actuators and auxiliary elements in Pneumatics and hydraulics, their applications and use of their ISO symbols, Synthesis and design of circuits (up to 2 cylinders)–pneumatic, electro- pneumatics and hydraulics, electro-hydraulics	08
5	**Control System** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	08
6	**Discrete Control System PLC (Programming Logic Control)Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc
2. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
3. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
4. Introduction to Mechatronics and Measurement Systems, Alciatore and HistandTata McGraw-Hill
5. Mechatronics, Necsulescu, Pearson education
6. Mechatronics - Electromechanics and Control Mechanics , Mill Springer-Verlag
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
8. Mechatronics - Electronics in products and processes , Bradley, et al. Chapman and Hall
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
10. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
11. Pneumatic Circuits and Low Cost Automation by Fawcett JR
12. The Art of Electronics, Horowitz and Hill Cambridge, University Press
13. Electromechanical Design Handbook , Walsh, McGraw-Hill
14. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
15. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, Addison Wesley
16. Principles and Applications of Electrical Engineering , Rizzoni, Irwin Publishing
17. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , KammIEEE
18. Modeling and control of Dynamic Systems, Macia and Thaler, Cengage Learning, India Edition
19. Mechatronics, A. Smaili, F. Mrad, OXFORD Higher Education.
20. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
21. Industrial Hydraulics: Pippenger
22. Vickers Manual on Hydraulics
23. Computer Numerical Control of Machine Tools: Thyer. G.R.
24. Pneumatic Applications: Deppert Warner & Stoll Kurt
25. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
26. Hydraulics and Pneumatics for Production: Stewart
27. Hydraulic Valves and Controls: Pippenger
28. Fundamentals of pneumatics: Festo series
29. Automatic Control Engineering: Francis. H. Raven.
30. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
31. Mechatronics, HMT
32. System Identification: Theory for the User (2nd Edition) , Lennart Ljung
33. Design with Microprocessors for Mechanical Engineers, StifflerMcGraw-Hill

Course Code	Course/Subject Name	Credits
MEDLO6022	**Robotics**	**04**

Objectives:

1. To study the basics of robotics and its control
2. To study various design principles of robotics through kinematic analysis, workspace analysis, and trajectory planning
3. To study applications of robots in industrial inspection and material handling
4. To study the role of a robot as a humanoid

Outcomes: Learner will be able to…

1. Demonstrate the basic functioning of a robot
2. Identify various components of robots
3. Carryout kinematic analysis, workspace analysis, and trajectory planning for a robot
4. Identify suitable sensors/actuators for robot
5. Select an appropriate robot for given industrial inspection and material handling systems.
6. Illustrate various aspects of a robot as a humanoid

Module	Details	Hrs.
01	**Introduction** Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Actuators and sensors, Drives and transmission systems, End effectors, Applications of robots	08
02	**Kinematics of Robots** **Direct:** Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots. **Inverse:** The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot. **Mobile Robot Kinematics** Introduction, Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Mobile robot maneuverability, Degree of mobility, Degree of steerability, Mobile robot workspace, Degree of freedom, Holonomic robots, Path and trajectory considerations, Motion control, Open loop control, Feedback control.	10
03	**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - Continuous path motion, Interpolated motion, Straight line motion and Cartesian space technique in trajectory planning.	10
04	**Sensors & Actuators** Sensors: Selection of sensors (Displacement, temperature, acceleration ,force/pressure) based on static and dynamic charecterstics, Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08

05	**Robots for Inspection and Material Handling** Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations Concepts of material handling, Principles and considerations in material handling systems design, Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and Hoists, Advanced material handling systems, Automated guided vehicle systems, Automated storage and retrieval systems, Bar code technology, Radio frequency identification technology	08
06	**Humanoids** Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, and sound, Vision, Tactile Sensing, Models of emotion and motivation, Performance, Interaction, Safety and robustness, Applications, Case studies	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Yoram Korean, “Robotics for engineers”, McGrew Hill Co.
2. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
3. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press
4. R.K. Mittal and I.J. Nagrath, “Robotics and Control”, TMH Publications
5. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning
6. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robtics and Automation Sensor – Based integration, Academic Press
7. K.S.Fu, R.C.Gonzalex, and C.S.G.Lee, “Robotics Control Sensing, Vision and Intelligence”, McGrew hill Book co.
8. Hartenberg and Denavit, “Kinematics and Synthesis of linkages”, McGrew Hill Book Co.
9. A.S. Hall, “Kinematics and Linkage Design”, Prentice Hall
10. J.Hirchhorn, “Kinematics and Dynamics of Machinery”, McGrew Hill Book Company

11. P.A. Janaki Raman, “Robotics and Image Processing An Introduction”, Tata McGraw Hill Publishing company Ltd.
12. Richard D Klafter, Thomas A Chmielewski, and Michael Negin, “Robotics Engineering – An Integrated Approach”, Eastern Economy Edition, Prentice Hall of India P Ltd.
13. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA
14. Alonzo Kelly, Karl Iagnemma, and Andrew Howard, “Field and Service Robotics”, Springer
15. Riadh Siaer, “The future of Humanoid Robots- Research and applications”, Intech Publications

Course Code	Course Name	Credits
MEDLO6023	**Industrial Automation**	**4**

Objectives:

1. To study the need for the automation, its advantages and limitations
2. To study the basic functional elements of automation
3. To familiarise with the levels of automation and strategies of automation
4. To acquaint with control of mechanical operations involving pneumatic, electric, hydraulic and electronic systems

Outcomes: Learner will be able to…

1. Demonstrate basics of industrial automation
2. Identify various types of automation
3. Demonstrate use of automated controls using pneumatic and hydraulic systems.
4. Illustrate the control systems in automated system.
5. Demonstrate applicability of PLC in process industry
6. Design elecrto-pneumatic circuits

Module	Detailed Contents	Hrs.
01	**Introduction to Automation**: Definition and fundamentals of automation, reasons for Automating, basic elements of an automated system: Power, Program and control system **Advanced automation functions:** safety, maintenance & repair diagnosis, error detection and recovery **Levels of automation** **Automation principles and strategies:** USA principle, ten strategies of automation and production system, automation migration strategy	06
02	**Mechanization and Automation:** Mechanization and automation, product cycle, hard Vs flexible automation, Capital- intensive Vs low cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc.	08
03	**Pneumatics and hydraulics:**Hydraulic and pneumatic devices-Different types of valves , Actuators and auxiliary elements in Pneumatics & hydraulics , their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	14
04	Sensors & Actuators Sensors: Selection of sensors (Displacement, temperature, acceleration, force /pressure) based on static and dynamic characteristics Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	06

05	**Industrial control systems:** Process industries versus discrete manufacturing industries, Continuous verses discrete control, Computer process control, Forms of computer process control Discrete control using PLC- discrete process control, Programmable logic controller, its architecture,ladder digs, Ladder Logic Programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	10
06	**Robots and their applications:** Introduction to robots, Types, Classifications, Selection of robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications of robots	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. M.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education,New Delhi
2. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, “Product Design for manufacture and Assembly”, CRC Press
3. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
4. Yoram Korean, “Robotics for engineers”, McGrew Hill Co
5. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications”, Prentice Hall.
6. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
7. Industrial Hydraulics: Pippenger
8. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
9. Pneumatic Circuits and Low Cost Automation: by Fawcett J.R.
10. Fundamentals of pneumatics: Festo series

Course Code	Course/Subject Name	Credits
MEL601	**Metrology and Quality Engineering**	**1**

Objectives:

1. To familiarise with working of gauges
2. To acquaint with gear parameter measurement
3. To acquaint with operations of precision measurement, instrument/equipment for measurement
4. To inculcate the fundamentals of quality concepts and statistics in metrology

Outcomes: Learner will be able to…

1. Measure linear and angular dimensions
2. Measure surface roughness
3. Measure various parameters of gear tooth profile
4. Use optical profile projector for measurement
5. Use various instruments for measurement of screw threads
6. Measure flatness by Autocollimator / Interferometry method

Six Experiments need to be performed on the below mentioned topics:

Sr. No.	**Topic**
1	Vernier Calliper, Micrometer and Bevel Protractor for linear and angular measurement
2	Surface measurement by Surface roughness tester
3	Gear measurement – Gear tooth Vernier calliper / Parkinson gear tester
4	Screw Thread Measurement – screw thread Micrometer, Floating carriage micrometer /bench micrometer
5	Optical profile projector for miniature linear / angular measurements of screw / gear or components
6	Tool maker’s microscope for linear / angular measurement of single point tools
7	Comparator – Mechanical / Pneumatic type
8	Flatness measurement by Autocollimator / Interferometry method
9	QC charts for 50 sample readings of OD / ID of specimen and printouts

Term-Work

Consists of minimum six experiments from the above list and presented with Aim, Apparatus/equipment’s, and Introduction, Working principle, Diagram, method, observation table, Analysis, Results and conclusion/inferences.

Also, minimum 5 assignments to help smooth conducting of laboratory exercises and one case study relevant to contents

Project Based Learning may be incorporated by judiciously reducing number of assignments

Distribution of marks for term work shall be as follows:

Laboratory work**:**	**15 marks**
Assignments:	**05 marks**
Attendance**:**	**05 marks**

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
   a) Practical performance ……**15** marks
   b) Oral …… ………………. .**10** marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL602	**Machine Design –I ***	**1**

Objectives:

1. To study the basic design principles
2. To familiarize with use of design data books & various codes of practice
3. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Design shaft under various conditions
2. Design Knuckle Joint / cotter joint
3. Design Screw Jack/C-clamp along with frame
4. Design Flexible flange couplings/ Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardise the designed dimensions

Term Work: (Comprises a & b)

a) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on **A3 size sheets**.

1) Knuckle Joint / cotter joint
2) Screw Jack
3) Flexible flange couplings
4) Leaf springs
5) C-clamps along with the Frame

b) Assignment: Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

1) Bolted and welded joints
2) Combined stresses problem using theory of failure.
3) Shaft design (solid and hollow shaft)
4) Design against fluctuating loads (finite and infinite life)

The distribution of marks for term work shall be as follows:

• Part - a :	15 marks.
• Part--b :	05 marks.
• Attendance:	05 Marks.

Course Code	Course Name	Credits
MEL603	**Finite Element Analysis**	**1**

Objectives:

1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to…

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

a) List of Experiments: Students should use the commercial software or programmes form the text-books or self-developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal. The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.

b) Course Project:

A group of not more than four students, shall do Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.

The distribution of marks for term work shall be as follows:

Part a:	15 marks.
Part b:	05 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
   a) Practical performance ……**15** marks
   b) Oral …… ………………. .**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEL604	**Refrigeration and Air Conditioning TW/Practical**	**1**

Objectives

1. To study operating principles of Vapour Compression system
2. To study components of refrigeration and air conditioning systems
3. To study controls and applications of refrigeration and air conditioning

Outcomes: Learner will be able to…

1. Demonstrate fundamental principles of refrigeration and air conditioning
2. Identify and locate various important components of the refrigeration and air conditioning system
3. Represent various refrigeration and air conditioning processes using psychometric chart
4. Operate and maintain refrigeration system
5. Operate and maintain air conditioning system
6. Simulate VCRS

Part A: List of Experiments

Trial on window air conditioner or Air Conditioning Test Rig
Trial on water cooler/Refrigeration Test Rig
Trial on Ice Plant
Trial on cooling tower

Part B: Demonstrations/Reports/Assignments/Simulations

Demonstration of domestic refrigerator along with wiring diagram
Demonstration of leak detection, evacuation and charging of refrigerant
Report on different protocols to regulate global warming
Visit report of Refrigeration establishment like Cold storage plant or ice plant or air-conditioning plant
Assignment on humidification and dehumidification, heating and cooling, mixing of two air streams
Steady state Simulation of VCR system with developed code or any analytical software

Term work

Term work shall consists of minimum Three Laboratory Experiments, at least one demonstration exercise, Industrial Visit Report, at least one assignment consisting of numerical based on Refrigeration and Air Conditioning and one simulation exercise on VCR

The distribution of marks for term work shall be as follows:

Part a:	15 marks.
Part b:	05 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Practical examination (in a group of not more than 5 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:
   a. Practical performance ……**15** marks
   b. Oral …… …………………**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 605	**Mechatronics Lab**	**01**

Objectives

1. To study sensors and actuators
2. To study control systems
3. To study automation

Outcomes: Learner will be able to…

1. Demonstrate implementation of interfacing sensors and actuators using microcontrollers
2. Demonstrate of interfacing various utilities with microcontrollers
3. Demonstrate discrete control system using PLC microcontroller
4. Design and develop a control system for specific use
5. Implement program to PLC system and demonstrate its application
6. Develop pneumatic circuits for a specific system

The laboratory experiments should be based on the following

Group 1: Sensors & Actuators

1. Theoretical & Experimental Implementation of Interfacing of Sensors using microcontroller and determination of sensor characteristics such as Static Characteristics (Sensitivity, Accuracy, Range, Resolution etc.), Dynamic Characteristics (Transient Response and Frequency Response)
2. Measurement and Calibration of Load / Force (*It is suggested to determine all characteristics of sensor mentioned in previous experiments)*
3. Measurement, Calibration and Comparison of Temperature Sensors (Thermocouple, RTD and Thermistor) *(It is suggested to determine all characteristics of sensor mentioned in previous experiments)*
4. Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table *(It is suggested to program to vary the position of rotary or XY table and compare the positioning accuracy using standard calibrated angular or linear sensor)*
5. Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup *(It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics)*
6. Interfacing of Water Heater with microcontroller and its programming for determination of its transient and steady state characteristics *(It is suggested to program to vary the input current to heater and determine its transient and steady state characteristics)*

Group 2: Control Systems

1. Experimental demonstration of Discrete control system using PLC microcontroller using standard PLC demo setup (Bottle filling Machine, Traffic Light Signal, Water heater and its stirring System etc.). *(here it is suggested to carry out ladder programing and demonstrate its operation)*
2. System Identification of Spring Mass Damper System for step input & harmonic input and determination of poles and zeros of system. *(Spring Mass Damper setup with all required position sensors mounted is to be characterized for step input, it is suggested to determine transfer function (i.e. input output relation) of the setup and plotting its transient and frequency response (Bode plot))*
3. Design & Experimental Implementation of PID control strategy for Spring Mass Damper Setup to control precisely position of mass. (*it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system*).
4. Design & Experimental Implementation of PID control strategy for DC motor speed control under varying loading conditions and effect of variation of load is to be studied.
5. Design & Experimental implementation of PID control strategy for Real Time Temperature Control of furnace *(it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system)*.
6. Modeling and design of control system for quarter car suspension model using any suitable modeling and analysis software.

Group 3: Automation

1. Real time Logic implementation for traffic Control demo setup and it is necessary to carry out ladder programming and implement program to PLC system and demonstrate its operations
2. IOT: Real time interfacing of sensors (temperature, humidity, position, level etc.) and actuator (stepper motor, dc motor, servo motor etc.) with microcontroller and Ethernet shield and controlling the actuator and monitoring of sensor output remotely using internet.
3. Robotics: Real Time demonstration of line following robot using standard robotic kit
4. Demonstration and study of functions of components of robotics arm.
5. Visualization of DH parameters in Roboanalyzer.(*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com)
6. Designing sequential operation for two cylinders using electro-hydraulic circuits
7. Designing sequential operation for two cylinders using electro- pneumatic circuits
8. Development of pneumatic circuits to understand pneumatic components and their working

Term work

Term work shall consists of minimum Nine Experiments, Three from each group mentioned above

The distribution of marks for term work shall be as follows:

Laboratory Work:	20 marks.
Attendance:	05 Marks.

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/oral based on contents
2. Practical examination (in a group of not more than 4 students) duration is 2 hours
3. Distribution of marks for practical/Oral examination shall be as follows:
    a. Practical performance ……**15** marks
    b. Oral …… …………………**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEC701	**Machine Design – II**	**4**

Objective:

1. To acquaint with functional and strength design principles of important machine elements
2. To familiarise selection of standard elements such as rolling element bearings, belts etc.

Outcomes: Learner will be able to…

1. Select appropriate gears for power transmission on the basis of given load and speed
2. Design gears based on the given conditions.
3. Select bearings for a given applications from the manufacturers catalogue.
4. Select and/or design belts and flywheel for given applications
5. Design cam and follower mechanisms.
6. Design clutches and brakes

Module	Details	Hrs.
01	**Design of Gears:** 1.1 **Gears:** Design of spur, helical, bevel and worm gears with strength, wear and thermal considerations 1.2 **Gear Box:** Two stage Gear box with fixed ratio consisting of spur, helical and bevel gear pairs: gear box housing layout and housing design	**14**
02	2.1 **Rolling Contact Bearings:** Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)	**05**
03	1.1 **Sliding Contact Bearings:** Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydro static bearings, Types and selection of Mechanical seals	**05**
04	4.1 **Design of Cams and Followers:** Design of Cam and Roller follower mechanisms with spring and shaft	**06**
05	5.1 **Design and selection of Belts:** Flat and V-belts with pulley construction 5.2 **Design of Flywheel** – Introduction, Fluctuation of energy and speed, turning moment diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms, Construction of flywheel 5.3 Design and selection of standard roller chains	**10**
06	6.1 **Design of Clutches:** Introduction, types, Basic theory of plate and cone type clutches, Design of single plate, multi-plate and cone clutches, with spring, lever design and thermal, wear considerations. 6.2 **Design of Brakes:** Design of single shoe brake	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

Course Code	Course/Subject Name	Credits
MEC702	**CAD/CAM/CAE**	**04**

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to…

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects & store and manage data.
3. CAM Toolpath Creation and NC- G code output.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

Modules	Details	Hrs.
01	**Computer Graphics and Techniques for Geometric Modeling** Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	**Transformation, Manipulation & Data Storage** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering. **Application Programming Interface (API)** Concept of customizing applications by writing programs, Fusion Object Model, Creating Scripts and Add-Ins, Document and assembly structure, Attributes, Creating Programs for Assemblies, Joint, B- Rep & Geometry.	08
03	**Design to Manufacturing (CAM)** 2D Machining Strategies, 3D Machining Strategies, Fixture Component Terminology, Work Coordinate System Terminology, Create setups, Apply 2D operations, Facing, 2D adaptive clearing, 2D contour. Chamfer milling, Bore ,Tool simulation and stock material removal , Produce setup sheets , Product NC code via post processing,	08
04	**Computer Aided Engineering (CAE)** Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08
05	**Computer Integrated Manufacturing & Technology Driven Practices** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08

06	**Rapid Prototyping and Tooling** Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*

14. “Flexible Manufacturing Systems” by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. “Mathematical Elements for Computer Graphics”, Rogers D F I and Adams J A, McGraw-Hill.
17. “Computer Integrated Manufacturing Hand Book” by Eric Teicholz, Joel N. Orr, McGraw Hill International Editions
18. “Rapid Prototyping” Chee Kai ChuaWorld Scientific Publishing
19. “Rapid Prototyping:Principles and Applications” RafiqNoorani, Wiley
20. “Rapid Prototyping:Principles and Applications” C.K. Chua,K.F.Leong, C.S. Lim World Scientific Publishing
21. “Rapid Prototyping and Manufacturing” P. F. Jacobs, Society of Manufacturing Engineers.

Course Code	Course/Subject Name	Credits
MEC703	**Production Planning and Control**	**4**

Objectives:

1. To provide an exposure to Production Planning & Control (PPC) and its significance in Manufacturing Industries
2. To give insight into the ongoing & futuristic trends in the control of inventory
3. To appraise about need and benefits of planning functions related to products and processes
4. To give exposure to production scheduling and sequencing so as to optimise resources

Outcomes: Learner will be able to…

1. Illustrate production planning functions and manage manufacturing functions in a better way
2. Develop competency in scheduling and sequencing of manufacturing operations
3. Forecast the demand of the product and prepare an aggregate plan
4. Develop the skills of Inventory Management and cost effectiveness
5. Create a logical approach to Line Balancing in various production systems
6. Implement techniques of manufacturing planning and control

Module	Details	Hrs
1	**Concepts of PPC:** 1.1. Manufacturing systems- components and types, need for PPC, functions of PPC, relationship of PPC with other functions 1.2. Factors influencing PPC in the organization, manufacturing methods- projects & jobbing products, batch, mass / flow production, continuous / process production. 1.3. Organization of PPC- status of PPC department, internal structure, degree of centralization, PPC as an integrated approach 1.4. Prerequisites of PPC – data pertaining to design, equipment, raw materials, tooling, performance standards, labour and operating systems	**06**
2	**Forecasting, Aggregate planning, Capacity planning** 2.1. Forecasting: Need for forecasting, role of forecasting in PPC, forecasting methods of qualitative type like judgment techniques. Forecasting methods of quantitative types like time series analysis, least square method, moving averagemethod, exponential smoothing method. Forecasting Errors and Forecasting Bias 2.2. Aggregate planning : Concept of aggregate planning, decision rules, strategies and methods 2.3. Capacity Planning: Measurement of capacity, Measures of capacity, Factors influencing effective capacity, short range, medium range and long range capacity planning, Rough cut capacity planning.	**08**
3	**Inventory Control:** 3.1. Basic concepts of inventory, Types of inventory, purpose of holding stock and influence of demand on inventory, Costs associated with Inventory management. 3.2. Inventory Models: Deterministic models - instantaneous stock replenishment model, Production model, planned shortages and price discount model, Probabilistic models-fixed quantity system(Q-system) and Fixed period system (p-system) 3.3. Selective Inventory Control techniques - ABC analysis, HML analysis and VED analysis	**08**
4	**Process Planning and Line Balancing** 4.1 Process planning: Prerequisite information requirement, steps in process planning, process planning in different situations, documents in process planning, machine / process selection & Computer Aided Process Planning 4.2 Line Balancing: objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	**08**
5	**Production Scheduling and Sequencing** 5.1 **Scheduling**: Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems.	**10**

	Project scheduling by using elements of network analysis –PERT & CPM, cost analysis & crashing, resource leveling 5.2 **Sequencing:** Product sequencing, dispatching, progress report & expediting and control. Johnson’s Rule for optimal sequence of N jobs on 2 machine. Process n Jobs on 3 Machines (n/3 problem) and Jackson Algorithm. Processing of 2 Jobs on m Machine (2/m) problem	
6	**MRP, MRP II, ERP** 6.1. Material Requirement planning(MRP) and Manufacturing Resource Planning (MRP-II) - general concepts, types of demands, Inputs to MRP, MRP objectives, outputs of MRP, Estimation of planned orderreleases. Benefits and Limitations of MRP II 6.2. Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, critical success factors of ERP, Case studies of success and failure of ERP implementations, ERP packages	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Production Planning and Control – Samuel Eilon.
2. Production Planning and Control – L C Jamb
3. Production Planning and Control, W. Boltan-Longman Scientific & Technical
4. Production Systems- Planning, Analysis& Control, James. L. Riggs-John Wiley &Sons
5. Manufacturing Planning and Control Systems, Thomas E. Vollman, WilliamL.Berry& Others-Galgotia Publishers
6. Manufacturing Process Planning and Systems Engineering, AnandBewoor-Dreamtech Press
7. Production and Operations Management, S.N.Chary- TMH publishing company
8. Modernization & Manufacturing Management, L.C. Jhamb - Everest PublishingHouse

Course Code	Course/Subject Name	Credits
MEDLO7031	**MECHANICAL VIBRATION**	**4**

Objectives:

1. To study basic concepts of vibration analysis
2. To acquaint with the principles of vibration measuring instruments
3. To acquaint with the practices of monitoring health conditions of the systems

Outcomes: Learner will be able to…

1. Develop mathematical model to represent dynamic system.
2. Estimate natural frequency of mechanical element / system.
3. Analyse vibratory response of mechanical element / system.
4. Estimate the parameters of vibration isolation system and
5. Control the vibrations to the acceptable level using basic vibration principles
6. Handle the vibration measuring instruments

Module	Details	Hrs.
1	**1.1 Basic Concepts of Vibration:** Introduction, classification, terminology, modelling vibration analysis **1.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by D'Alembert's Principle, Newton, Energy, Lagrangian and Rayleigh's method	**08**
2	**Multi Degree of Freedom System:** **2.1 Undamped free vibration:** Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems **2.2 Eigen Values and Eigen vectors:** for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	**10**
3	**Free Damped Single Degree of Freedom Vibration System:**Types of dampers, Viscous damped system- translatory and rotary systems, Coulomb's damping- final rest position of body in coulomb damping, motion with negative damping factor,	**06**
4	**4.1 Forced Single Degree of Freedom Vibratory System:**Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation **4.2 Vibration Isolation and Control:** Conventional Methods: By mass /Inertia, stiffness, damping (vibration isolation principles) Force Transmissibility, motion transmissibility, typical isolators & mounts. Introduction to Semi-Active and Active Vibration control.	**10**
5	**5.1 Vibration Measuring Instruments:**Principle of seismic instruments, vibrometer, accelerometer- undamped, damped **5.2 Introduction to Conditioning Monitoring and Fault Diagnosis:**Introduction to conditioning monitoring and fault diagnosis,Condition & Vibration Monitoring Techniques, Condition / vibration monitoring data collection. Signature analysis	**07**
6	**Non-Linear Vibration:**Basics of Non-linear vibration, systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase –plane technique, Duffing's equation, Jump phenomenon, Limit Cycle, Perturbation method.	**07**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
2. Mechanical Vibraitons by G. K. Grover
3. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
4. Vibration Analysis by P. Srineevasan, Tata McGraw Hill
5. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
6. Theory and Practice of Mechanical Vibrations by J.S.Rao, K. Gupta, New Age International Publications

7. Mechanical Vibrations by Den, Chambil, Hinckle
8. Mechanical Vibrations by J.P.Den Hartog, McGraw Hill Book Company Inc
9. Introduction to Dynamics and Control by Leonard Meirovitch, Wiley, New York
10. Elements of Vibration Analysis by Leonard Meirovitch, McGrmv- Hill, New York
11. Dynamics and Control of Strucdtures by Leonard Meirovitch, Wiley, New York
12. Matrices and Transformations by Antony J. Pettofrezzo, Dover, New York
13. Principles of Vibration by Benson H. Tongue, Oxford University Press
14. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
15. Vibrations by Balakumar Balachandan, Edward Magrab, Cengagae Learning

Course Code	Course/Subject Name	Credits
MEDLO7032	**AUTOMOBILE ENGINEERING**	**04**

Objectives:
1. To impart the understanding of important mechanical systems of an automobile
2. To provide insight into the electrical systems of an automobile
3. To familiarize with the latest technological developments in automotive technology

Outcomes: Learner will be able to…
1. Illustrate the types and working of clutch and transmission system.
2. Demonstrate the working of different types of final drives, steering gears and braking systems
3. Illustrate the constructional features of wheels, tyres and suspension systems
4. Demonstrate the understanding of types of storage, charging and starting systems
5. Identify the type of body and chassis of an automobile
6. Comprehend the different technological advances in automobile

Module	Details	Hrs
1	**Clutch :** Requirements of Clutches, Types of Clutches; Single Plate, Multi-plate, Wet Clutch, Semi-centrifugal, Centrifugal. Clutch materials. Clutch operating mechanisms; Mechanical, Electric, Hydraulic and Vacuum. Free Pedal Play. **Transmission:** Necessity of gear box. Sliding mesh, Constant mesh, and Synchromesh Gear selector mechanisms. Overdrives and hydrodynamic torque converter, Trouble shooting and remedies. **Propeller Shaft and Axle:** Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints Types of live axles; semi, three quarter and full floating axles Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine	**09**
2	**Final Drive and Differential :** Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and non-slip differential, Trouble shooting and remedies **Steering System :** Steering geometry, Steering requirements, Steering linkages and steering gears. Over steer and under steer, Cornering power, Reversibility of steering gears. **Braking System:** Requirement of brake, Classification of brakes, Brake Actuation Methods; Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake trouble shooting, Introduction to antilock braking system (ABS)	**08**
3	**Suspension System** Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types **Wheels and Tyres:** Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass	**07**
4	**Automotive Electrical System :** **Storage System:** Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline, ZEBRA, Sodium Sulphur and Swing batteries **Charging System:**	**06**

	Dynamo: Principle of operation, Construction and Working. Regulators, combined current and voltage regulator. Alternator: Principle of operation, Construction, Working. Rectification from AC to DC **Starting system:** Requirements, Various torque terms used, Starter motor drives; Bendix, Rubber compression, Compression Spring, Overrunning Clutch. Starter motor solenoids and switches	
5	**Body Engineering:** Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Chassis types and structure types: Open, Semi integral and integral bus structure Frames: functions and types of frames, Loads on frames, Load distribution of structure, Location of power plant	**06**
6	**Recent trends in Automobiles :** **Intelligent Vehicle Systems :** Cruise Control, Adaptive Cruise Control (ACC), Electronic Stability Program (ESP), Electronic Brake Distribution (EBD), Traction Control System (TCS). Integrated Starter Alternator (ISA)	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. The Automobile by Harbans Singh Reyat
3. The Automobile Engineering by T.R. Banga and Nathu Singh
4. Automotive Engineering Fundamentals by Richard Stone, Jeffrey K. Ball,SAE International
5. Vehicle body engineering by J Powlowski
6. Automobile Mechanics, N. K. Giri, 8thEdition, Khanna Publishers
7. Bosch Automotive Hand Book, 6thEdition, SAE Publications
8. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill
9. Motor vehicles by T. K. Garrett, K. Newton and W. Steeds
10. Automotive Mechanics by Joseph Heitner
11. Automobile Electrical and Electronics by Tom Denton
12. Automotive Electrical Equipment by P. L. Kohli
13. Computerised Engine Control by Dick H. King

Course Code	Course/Subject Name	Credits
MEDLO7033	**Pumps, Compressors and Fans**	**4**

Objectives

1. To study of Different types of Pumps, Compressors & Fans
2. To familiarise design aspects of Pumps, Compressors & Fans

Outcomes: Learner will be able to…

1. Select suitable Pump
2. Design a reciprocating pump and analyse its performance
3. Design a centrifugal pump and analyse its performance
4. Demonstrate basic principles of fans and blowers
5. Design fan/blower and analyse its performance
6. Design a compressor and analyse its performance

Module	Detailed Contents	Hrs.
01	**Introduction to Fluid Machinery:** Introduction to pumps, Introduction to blowers and compressors, Basic equations of energy transfer between fluid and rotor, Performance characteristics, Dimensionless parameters, Specific speed, stage velocity triangles, work and efficiency.	04
02	**Reciprocating Pumps and Centrifugal Pumps:** Introduction: Types, Component and Working of Reciprocating pump and Centrifugal Pumps, Discharge, Work done and power required to drive for single acting and double acting, Coefficient of discharge, slip, Effect of acceleration of piston on velocity and pressure, indicator diagram, Air Vessel, Operating characteristics.	06
03	**Design & Analysis of Pumps:** Design procedure and design optimization of Pumps, selection of pumps, Thermal design- Selection of materials for high temperature and corrosive fluids, Hydraulic design- Selection of impeller and casing dimension using industrial manuals	08
04	**Introduction to Fans, Blowers and Compressors:** Classification of blowers, Basics of stationary and moving air, Eulers characteristics, velocity triangles and operating pressure conditions, Equations for blowers, Losses and hydraulic efficiency, flow through impeller casing, inlet nozzle, Volute, diffusers, leakage, mechanical losses, surge and stall, Applications of blowers and fans **Compressors:** Basic theory, classification and application, Working with enthalpy-entropy diagram	06
05	**Design and Analysis of Fans and Blowers:** Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, Design procedure for selection and optimization of Blowers. Stage pressure rise, stage parameters and design parameters, Design of impeller and casing dimension in aerodynamic design	06
06	**Design & Analysis of Compressors:** Construction and approximate calculation of centrifugal compressors, impeller flow losses, slip factor, diffuser analysis, performance curves of centrifugal compressors, Basic design features of axial flow compressors; velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage of axial flow compressors	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Principles of Turbo machinery by Shepherd, D.G., Macmillan
2. Centrifugal Pump Design by John Tuzson, John Wiley
3. Blowers and Pumps by Stepanff, A.J., John Wiley and Sons Inc.
4. Centrifugal pumps and blowers by Austin H. Chruch, John Wiley and Sons
5. Centrifugal Pumps Design and Applications by Val S.Labanoff and Robert Ross, Jaico P House
6. Pump Hand Book by Igori Karassik, McGraw-Hill International Edition
7. Pumps by G.K.Sahu, New age international
8. Turbine, Compressors and Fans by S.M.Yahya, Tata Mc-Graw Hill Publishing Company
9. Fluid Mechanics and Hydraulic Machines by R. K. Bansal, Laxmi Publication
10. Gas Turbines by V. Ganeshan, Tata Mc-Graw Hill Publishing Company
11. Steam and Gas Turbine by R. Yadav,Central Publishing House, Allahabad

Course Code	Course/subject Name	Credits
MEDLO7034	**Computational Fluid Dynamics**	**4**

Objectives:

1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Outcomes: Learner will be able to…

1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discritisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyze the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection.	
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	
06	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Course Code	Course Name	Credits
ILO 7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life	05

	Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07

06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction ***1.1*** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.	09

	5.2 International relief aid agencies and their role in extreme events.	
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	**04**
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
MEL701	**Machine Design –II**	**1**

Objectives:

1. To familiarise applications of strength design principles for various machine elements
2. To make conversant with preparation of working drawings

Outcomes: Learner will be able to…

1. Design gears based on the given conditions
2. Design gearbox for a given application
3. Design cam & followers for a given condition
4. Design clutches for a given application
5. Design brakes for given condition
6. Select bearings for a given applications from the manufacturers catalogue

Term Work: (Comprises aand b)

a)

1. **Term work -** Shall consist of design and detailed assembly drawing of minimum two design problems form the mentioned list (computer aided drawing on **A3 size sheets**):
    1. Design of Gears and gear box
    2. Design of cam and followers
    3. Design of clutches
    4. Design of brakes

2. **Course Project:** Students in a group of two to four will be able to design and prepare working drawings of any system having minimum 5 to 6 components by applying the knowledge gained during the course.

b) **Assignment :** Each assignment containing at least 2- numerical based on following topics. These design exercises should be in the form of design calculations with sketches and/ or drawings.

1. Rolling contact bearings
2. Sliding contact bearing
3. Design of belt, chain and flywheel

The distribution of marks for term work shall be as follows:

Exercises & Drawing sheets:	15 Marks
Course Project:	05 Marks
Attendance:	05 Marks

End Semester Practical/Oral examination:

1. Each student will be given a small task of design, based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task.
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL702	**CAD/CAM/CAE**	**01**

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to…

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects as well as store and manage data.
3. Create CAM Toolpath and prepare NC- G code
4. Apply rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises

1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work

Term work shall consist of

a. Any four exercises from 1 to 6 of above list
b. Part programming and part fabrication on CNC trainer
c. A course project in a group of not more than four students based on 8 and 9 of above list

The distribution of marks for term work shall be as follows:

Exercises	: 15 Marks
Course Project	: 05 Marks
Attendance	: 05 Marks

Assessment:

End Semester Practical/Oral Examination:

1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL703	**Production Planning and Control**	**01**

Objectives:

1. To provide an exposure related to Production Planning & Control (PPC)
2. To give exposure to production scheduling and sequencing

Outcomes: Learner will be able to…

1. Prepare a process sheet
2. Prepare a Gantt Chart
3. Forecast the demand of the product and prepare an aggregate plan.
4. Perform ABC analysis of a given problem
5. Develop the skills of Inventory Management and cost effectiveness.
6. Create a logical approach to Line Balancing for various production systems.

Term Work

The Term work shall comprise of the following:
At least six laboratory exercises/assignments comprising questions/problems

Sr No	**List of Laboratory Exercises (Any Six)**
1	Preparation of a Process sheet of a simple turned/milled component
2	Numerical example on Johnson's Algorithm
3	An example on network crashing
4	Preparation of a Gantt Chart
5	A real life example on ABC analysis
6	An example on MRP for planned released orders
7	An example on line balancing
8	Preparation of organization charts with functional relationship for any SME.

Project Based Learning may be incorporated by judiciously reducing number of laboratory exercises

The distribution of marks for term work shall be as follows:

- Lab work/assignments/exercise : **20** marks
- Attendance : **05** marks

Practical/Oral examination

1. Each student will be given a small task based on laboratory excercises, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:
   Excercise: 15 marks
   Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
MEC801	**Design of Mechanical Systems**	**4**

Objectives:

1. To familiarise with the concept of system and methodology of system design
2. To study system design of various systems such as snatch block, belt conveyors, engine system, pumps and machine tool gearbox

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Design material handling systems such as hoisting mechanism of EOT crane,
3. Design belt conveyor systems
4. Design engine components such as cylinder, piston, connecting rod and crankshaft
5. Design pumps for the given applications
6. Prepare layout of machine tool gear box and select number of teeth on each gear

Module	Details	Hrs.
01	Methodology & Morphology of design, Optimum design, system concepts in design.	04
02	**Design of Hoisting mechanism:** Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	10
03	**Design of belt Conveyors-** Power requirement, selection of belt, design of tension take up unit, idler pulley	06
04	**Engine Design (Petrol and Diesel):** Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	10
05	**Design of Pump:** **5.1 Design of main components of gear pump.** 1 Motor selection 2 Gear design 3 Shaft design and bearing selection 4 Casing and bolt design 5 Suction and delivery pipe **5.2 Design of main components of Centrifugal Pump:** 1 Motor selection 2 Suction and Delivery pipe 3 Design of Impeller, Impeller shaft 4 Design of Volute Casing	10
06	**Design of Gear Box:** Design of gear boxes for machine tool applications(Maximum three stages and twelve speeds), Requirements of gear box, determination of variable speed range, graphical representation of speeds, structure diagram, ray diagram, selection of optimum ray diagram, estimation of numbers of teeth on gears, deviation diagram, layout of gear box	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Use of standard design data books like PSG Data Book, Machine Design Data Book- design of engine parts by Khandare S.S and Kale A.V. are permitted at the examination and shall be supplied by the college.

References:

1. Machine Design Exercises by S.N.Trikha, Khanna Publications, Delhi
2. Mechanical Engineering Design byShigley J E and Mischke C R, McGraw Hill
3. Mechanical design analysis byM FSpotts, Prentice Hall Inc
4. Design of Machine Elements, Bhandari VB, TMH
5. Machine Design by Black PH and O Eugene Adams, McGraw Hill
6. Design Data by P.S.G. College of Technology, Coimbatore.
7. I S: 2825 Code for unfired pressure vessels
8. Mechanical Design Synthesis with Optimisation Applications byJohnson R C, Von Nostrand-Reynold Pub
9. Engineering Design by Dieter G E, McGraw Hill Inc
10. Design of machine tools by S K Basu and D K Pal, Oxford and IBH Pub. Co.
11. Machine tool design by NKMehta, TMH
12. Mechanical System Design by SP Patil, JAICO students Ed., JAICO Publishing House
13. Material Handling Equipment by Rudenko, M.I.R. publishers, Moscow
14. Machine Design-An Integrated Approach by Robert L. Norton, Pearson Education
15. Material Handling Equipments by N. Rudenko, Peace Publication
16. Material Handling Equipments by Alexandrov, Mir Publication
17. Machine Desgin by Reshetov, Mir Publication
18. Machine Design by R.C.Patel, Pandya, Sikh, Vol -I & II, C. Jamnadas & Co
19. Design of Machine Elements by V. M. Faires
20. Pumps: Theory, Design and Applications by G K Sahu, New Age International
21. Gear Design Handbook by Gitin Maitra
22. Design Data Book- Design of engine parts by Khandare S.S & Kale A.V

Course Code	Course/Subject Name	Credits
MEC802	**Industrial Engineering and Management**	**04**

Objectives

1. To familiarise with concept of integration of various resources and the significance of optimizing them in manufacturing and allied Industries
2. To acquaint with various productivity enhancement techniques

Outcomes: Learner will be able to…

1. Illustrate the need for optimization of resources and its significance
2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in method study and understanding of work content in different situations.
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Modules	Detailed contents	Hrs.
01	**Introduction to Industrial Engineering** History and contribution, Industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach to industrial engineering, definition and concept of productivity, productivity measurements, factors influencing productivity and productivity improvement techniques.	06
	Value Engineering and Value Analysis: Distinction between value engineering & value analysis and their Significance. Steps in value engineering & analysis and Check lists.	**05**
03	**Work study:** Method study, micro-motion study and principles of motion economy, Work measurement: time study, work sampling, standard data, PMTS; MOST	**10**
04	**Work system design:** Introduction to ergonomics and its scope in relation to work. Outline of discipline of anatomy, physiology and psychology, with respect to ergonomics building blocks such as anthropometry and biomechanics Job evaluation, merit rating, incentive schemes, wage administration and business process reengineering	**08**
05	**Facility Design:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems Concepts of Group Technology and cellular manufacturing	**09**
06	**Agile manufacturing:**Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing, Lean Manufacturing, Value Stream Mapping	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Introduction to Work study, ILO, Geneva, and Oxford & IBH Pub Co. Pvt. Ltd.
2. Ergonomics at Work, Murrell
3. Plant Layout and Material Handling, James M. Apple, John Wiley & Sons
4. Facility Layout and Location – An Analytical Approach, Richard L. Francis& John A. White, Prentice Hall
5. Production Planning and Control, Samuel Elion
6. Production and Operations Management, Joseph G. Monks
7. Quality planning and analysis, J M Juran, FM Gryana, TMH
8. Total Quality Management, D. H. Bester Field et al. prentice hall
9. TQM in new product manufacturing, HG Menon; TMH
10. Industrial Engineering and Management by Dr Ravi Shankar

Course Code	Course Name	Credits
MEC803	**Power Engineering**	**4**

Objectives

1. To study boilers, boiler mountings and accessories
2. To study utilization of thermal and hydraulic energy
3. To study gas turbine and its applications

Outcomes: Learner will be able to…

1. Compute heat interactions in combustion of reactive mixtures
2. Differentiate boilers, boiler mountings and accessories
3. Calculate boiler efficiency and assess boiler performance
4. Demonstrare working cycles ofgas turbines
5. Draw velocity triangles of impulse/reaction turbines and calculate performance parameters/efficiency
6. Demonstrate basic working of pumps

Module	Detailed Contents	Hrs.
01	**Combustion of Reactive Mixtures** Combustion reactions, Stoichiometric A/F ratio, Actual A/F ratio, Heat of combustion, Enthalpy of formation, First law of reactive system, Adiabatic flame temperature.	04
02	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency	12
03	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio	05
04	**Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency, Afterburner, Introduction to Turbojet, Turbofan, Ram jet, Turboprop and Rocket engine	05
05	**Impact of Jets:** Impact of jet on flat and curved plates **Water Turbines:** Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Impulse Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:**Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters	12
06	**Pumps** Classification of pumps - positive displacement and non - positive displacement Positive Displacement pumps: Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. **Centrifugal Pumps**	10

	Types - radial flow, mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc., self-priming pumps, series and parallel operation of pumps, system curve for branch network, determination of operating point, Cavitation in pumps, Determination of available and required NPSH	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Thermal Engineering, R K. Rajput, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, Dhanpatrai & Sons
3. Steam and gas turbine, R Yadav.
4. Fluid Mechancis and Machinery, C P S Ojha, Chandramouli and R Berndtsson, Oxford University Press
5. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
6. Hydraulic Machinery, Jagdish Lal
7. Hydraulic Machines, R K Rajput, S.Chand Publication

Course Code	Course/Subject Name	Credits
MEDLO8041	**Power Plant Engineering**	**4**

Objectives

1. Study basic working principles of different power plants
2. Study power plant economics

Outcomes: Learner will be able to…

1. Comprehend various equipment/systems utilized in power plants
2. Demonstrate site selection methodology, construction and operation of Hydro Electric Power Plants
3. Discuss working, site selection, advantages, disadvantages of steam power plants
4. Discuss operation of Combined Cycle Power Plants
5. Discuss types of reactors, waste disposal issues in nuclear power plants
6. Illustrate power plant economics

Module	Detailed Contents	Hrs.
01	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants	06
02	Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants	10
03	Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator	08
04	Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles, Problems	08
05	Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors- PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled, Advantages and limitations, nuclear power station, waste disposal.	08
06	Power Plant Economics: Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing, Problems.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Power Plant Engineering, A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, New Age International Publishers
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. Power Plant Engineering, P.K. Nag, 2nd Edition, TMH, New Delhi
4. A Text Book of Power Plant Engineering, R.K. Rajput, Laxmi Publications
5. Hydro-Electric and Pumped Storage Plants, M G Jog, New Age International Publishers
6. A Course in Power Plant Engineering, Arora, Domkundwar, DhanpatRai & Co
7. Power Plant Engineering, P.C. Sharma, S.K. Kataria& Sons
8. Power Plant Engineering, G.R. Nagpal, Khanna Publishers
9. Power station Engineering and Economy by Bernhardt G.A. Skrotzki and William A. Vopat, TMH
10. Power Plant Engineering, Manoj Kumar Gupta, PHI Learning
11. Nuclear Power Plant Engineering, James Rust, Haralson Publishing Company
12. Nuclear Power Plants, Edited by Soon Heung Chang, InTech Publishers

Course Code	Course/Subject Name	Credits
MEDLO8042	**Rapid Prototyping**	**04**

Objectives

1. To familiarise with importance of Rapid Prototyping in Product Development.
2. To acquaint with the Synergic Integration Technologies

Outcomes: Learner will be able to…

1. Select the feasible RP process
2. Selct the feasible RP material
3. Gauge and Hybridize the ever-evolving Protoyping Technologies
4. Contribute towards the Product Development at the respective domain in the industry
5. Apply RP to build working prototypes
6. Demonstrate basics of virtual reality

Module	**Detailed Contents**	**Hrs.**
01	Introduction: Product Development Cycle and the product Life Cycle. Problems in Product Development and the use of Synergic Integration Technologies. Relationship between Product Development Cost and the Selling Price. Where does RP stand. Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, supported file formats and introduction to Solid Modelling.	10
02	Laminated Object Manufacturing (LOM), principle of operation, possible approaches, steps, advantages and limitations. Stadard Machine Specifications. Fused Deposition Modelling (FDM), principle of operation, process steps, advantages and limitations. Stadard Machine Specifications. Stereolithography Apparatus (SLA): Principle, process steps, advantages and limitations, Stadard Machine Specifications. Selective Laser Sintering (SLS): Principle, process steps, advantages and limitations, Stadard Machine Specifications.	12
03	Solid Ground Curing (SGC): Principle, process steps, advantages and limitations, PhotoMasking comparative with SLA and LOM ObJet: Principle, process steps, advantages and limitations, applications, Stadard Machine Specifications. 3D Printing: Principle, process steps, advantages and limitations, classification of printer family, Stadard Machine Specifications, DIY procedures.	12
04	Rapid Tooling: Need for metallic tooling, approaches, RP Processes for Tooling, Silicon Rubber Molding, Epoxy Tooling, Spray Metal Tooling, Cast Kirksite Tooling, 3D KelTool, QuickCast.	05
05	Materials for Rapid Prototyping Systems: Nature of material, types of material; polymers, metals, ceramics and composites, liquid based materials; photo polymer development, solid based materials; powder based materials.	05
06	Reverse Engineering: Introduction to Digitizing Methods; contact type and non-contact type, brief introduction to the types of medical imaging. Virtual reality: Definition, features of VR, Technologies used in VR, Introduction to Augmented reality.	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Rapid Prototyping, Principles and Applications byRafiq I. Noorani, Wiley & Sons
2. Rapid Prototyping: Principles and Applications byChua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific
3. Rapid Manufacturing – An Industrialrevolution for the digital age by N.Hopkinson, R.J. M. Hauge, P M, Dickens, Wiley
4. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping byIan Gibson, Wiley
5. Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography byPaul F.Jacobs, McGraw Hill
6. Rapid Manufacturing byPham D T and Dimov S S, Springer Verlog

Course Code	Course Name	Credits
MEDLO8043	Renewable Energy Sources	4

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study economics of harnessing energy from renewable energy sources

Outcomes: Learner will be able to…

1. Demonstrate need of different renewable energy sources
2. Discuss importance of renewable energy sources
3. Discuss various renewable energy sourses in Indian context
4. Calculate and analyse utilization of solar and wind energy
5. Illustrate design of biogas plant
6. Demonstrate basics of hydrogen energy

Module	Detailed Contents	Hrs.
01	**Introduction to Energy Sources**: Renewable and non-renewable energy sources, Need for Renewable Energy Sources, Energy Consumption as a measure of Nation's development; Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources, Present status and current installations, Introduction to Hybrid Energy Systems.	07
02	**Solar Energy**: Merits and demerits, Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length, Methods of Solar Radiation estimation. **Solar Energy collection devices and Classification:** Flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, Solar Photovoltaic systems & applications.	12
03	**Wind Energy**: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.	10
04	**Energy from Biomass**: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	06
05	**Geothermal Energy**: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India. **Energy from the ocean**: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy	08
06	**Hydrogen Energy:** Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Renewable Energy:Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, Oxford University Press
3. Solar Energy: Principles of Thermal Collection and Storage by SP Sukhatme and J K Nayak, TMH
4. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill.
5. Wind Power Technology, Joshua Earnest, PHI Learning, 2014
6. Renewable Energy Sources, J W Twidell& Anthony D. Weir. ELBS Pub.
7. Energy Conversion Systems, R D Begamudre, New Age International (P) Ltd., Publishers, New Delhi ,2000.
8. Solar Photovoltaics: Fundamentals, Technologies and Applications, C S Solanki, 2ndEdition, PHI Learning
9. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York
10. Wind and Solar Power Systems, Mukund R Patel, CRC Press
11. Wind Energy Explained: Theory, Design and Application, J F Manwell, J.C.McGowan, A.L.Rogers, John Wiley and Sons
12. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison

Course Code	Course Name	Credits
MEDLO8044	**Energy Management in Utility Systems**	**4**

Objectives:

1. To familiarise principles of energy management and concept of energy management in utility systems
2. To study energy economics and auditing
3. To study electrical energy management, cogeneration and waste heat recovery.

Outcomes: Learner will be able to…

1. Demonstrate general aspects of energy management
2. Summarize and explain need for energy management, economics and auditing
3. Illustrate basics of energy economics and financial analysis techniques
4. Describe importance of thermal and electrical utilitie's maintenance
5. Assess potential and summarise benefits of waste heat recovery and cogeneration
6. Illustrate waste heat recovery and cogeneration methods

Module	Detailed Contents	Hrs.
01	**General Aspects of Energy Management**: Introduction to utility systems (Types) Current energy scenario: India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency, Energy Conservation Act	08
02	**Energy Auditing :** Need of Energy Audit, Types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting, Energy audit software. Material & Energy Balance	08
03	**Energy Economics:** Costing of Utilities - Determination of cost of steam, natural gas, compressed air and electricity. Financial Analysis Techniques - Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis	09
04	**Energy Efficiency in Thermal Utilities:** Energy performance assessment and efficiency improvement of Boilers, Furnaces, Heat exchangers, Fans and blowers, pumps, Compressors and HVAC systems. Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system	08
05	**Electrical Energy Management and Lighting:** Distribution and transformer losses. Electrical motors - types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003. **Lighting** - Lamp types and their features, recommended illumination levels, lighting system energy efficiency.	07
06	**Cogeneration and Waste Heat Recovery**, Cogeneration- Need, applications, advantages, classification, the cogeneration design process. Waste heat recovery- Classification and application, Potential for waste-heat recovery in Industry, Commercial WHR devices, saving potential. CDM projects and carbon credit calculations	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Energy engineering and management, AmlanChakrabarti, PHI Learning, New Delhi 2012
2. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, 7thEdition,The Fairmont Press Inc
3. Energy management Handbook, Wayne C. Turner, 5thEdition,The Fairmont Press Inc., Georgia.
4. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI, New Delhi
5. Energy Performance assessment for equipment and Utility Systems Vol. 1 to 4, Bureau of Energy Efficiency, Govt. of India
6. General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, Govt of India
7. Boiler Operators Guide,4thEdition, Anthony L Kohan, McGraw Hill
8. Energy Hand book, Robert L. Loftness,2nd Edition, Von Nostrand Reinhold Company
9. Sustainable Energy Management, MirjanaGolusin, SinisaDodic, Stevan Popov, Academic Press
10. Energy Management, Trivedi P R, Jolka K R, Commonwelth Publications, New Delhi
11. www.enrgymanagertraining.com
12. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:**	6

	Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management,Gido Clements, Cengage Learning
4. Project Management,Gopalan, Wiley India
5. Project Management,Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning**	5

	• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached	**04**

	6.2 Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
MEL801	**Design of Mechanical Systems**	**1**

Objectives:

1. To familiarise with the concept of system and methodology of system design
2. To study system design of various systems such as snatch block, belt conveyors, engine system, pumps and machine tool gearbox
3. To familiarise with the standard codes of professional practices in designing the various systems

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Design of hoisting mechanism of EOT crane,
3. Design belt conveyor systems
4. Design pumps for the given applications
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design of machine tool gearbox

Term Work: Comprises a& b

a) Term work - Shall consist of

1. Design and detailed assembly drawing (computer aided drawing on **A3 size sheets)** of minimum two design problems, from the following:
    - i) Design of hoisting mechanisms
    - ii) Design of belt conveyors
    - iii) Design of pumps
2. **Course Project:**Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected.

b) Assignment: Exercises on following topics in the form of design calculations with sketches and / or drawings.

1. Engine design
2. Design of gearbox

The distribution of marks for term work shall be as follows:

- Exercises and Drawing sheets : 10 marks.
- Assignments : 05 marks
- Course Project : 05 marks.
- Attendance : 05 Marks.

Assessment:

End Semester Practical/Oral examination:

1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Design Task:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
MEL 802	**Power Engineering**	**01**

Objectives

1. To familiarisewith boilers, boiler mountings and accessories using models/cut sections
2. To familiarise with hydraulic energy conversion devices

Outcomes: Learner will be able to…

1. Differentiate boilers
2. Differentiate boiler mountings and accessories
3. Conduct a trial on impilse turbine and analyse its performance
4. Conduct a trail on reaction turbine and analyse its performance
5. Conduct a trial on Centrifugal pump and analyse its perfromance
6. Conduct a trial on Reciprocating pump and analyse its perfromance

List of Experiments

1. Demonstration of Boilers
2. Demonstration of Boiler mountings and accessories
3. Trial on Impulse turbine
5. Trial on Reaction turbine
6. Trial on centrifugal pump (Single stage/Multistage)
7. Trail on receprocating pump
8. Visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

Assessment:

Term Work

Term work shall consist of all the experiments from the list, 3 assignments containing numerical based on maximum contents of the syllabus and a visit report

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments): **10 marks**

Assignments: **05 marks**

Visit report**: 05 Marks**

Attendance: **05 marks**

End Semester Practical/Oral Examination:

1. Students in a group (4 to 6) have to perform trial either on Impulse turbine, Reaction turbine, Centrifugal Pump or Reciprocating Pump and the same will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical-oral examination shall be as follows:

Trial:	15 marks
Oral:	10 marks

3. Evaluation of practical/oral examination to be done based on the performance
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEP701/ MEP801	**Project (I and II)**	**03 + 06**

Objectives:

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Outcomes: Learner will be able to…

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Guidelines for Project

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor

Students should use multiple literatures and understand the problem.

Students should attempt solution to the problem by experimental/simulation methods.

The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.

Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai

Students should be motivated to publish a paper in Conferences/students competitions based on the work

University of Mumbai

No. AAMS(UG)/ 135 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings & Services which was accepted by the Academic Council at its meeting held on August, 2017 **vide** item No. 6.23 relating to the revised syllabus as per Semester Based Credit and Grading System for Bachelor Engineering in Information Technology (Sem. – VII & VIII).

You are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Information Technology** at its meeting held on 27th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.23 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.23 (R) and that in accordance therewith, the revised syllabus of **B.E. (Information Technology) (Sem.- VII & VIII) (CBCS) (REV – 2019 'C' Scheme)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
29th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.23 (R)/11/07/2022

****

No. AAMS(UG)/135 -A of 2022-23 29th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Information Technology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Walfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

AC – 11 July, 2022

Item No. – 6.23 (R)

University of Mumbai

Revised Syllabus for
B.E. (Information Technology)
(Sem. - VII to VIII)
(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

Syllabus for Approval

O: ____________	**Title of Course**	B.E. (Information Technology)
O: ____________	**Eligibility**	After Passing Third Year Engineering
R: ____________	**Passing Marks**	40%
No. of years/Semesters:		8 semesters
Level:		~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:		~~Yearly~~ / Semester
Status:		~~New~~ / Revised
To be implemented from Academic Year:		With effect from Academic Year : 2022-23

Dr. Deven Shah
Chairman,
Ad-hoc Board of
Studies in Information
Technology

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande Dr. Anuradha Muzumdar
Associate Dean DeanFaculty of Science and Technology Faculty of Science
and TechnologyUniversity of MumbaUniversity of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By Board of Studies Team

It is our honor and a privilege to present the Rev-2019 ‘C’ scheme syllabus of Bachelor of Engineering in InformationTechnology (effective from year 2019-20) with inclusion of cutting edge technology.Information Technology is comparatively a young branch among other engineering disciplines in the Universityof Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbaithat IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like betterplacement and promotion of entrepreneurship culture among students, and increased Industry InstituteInteractions.Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which isnot in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in thesyllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will bemaster in one of the IT domain.The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers futuretrends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai forsignificant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts fortheir valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in thefield of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. ApplyCore Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)

Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Fourth Year Information Technology
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	--	3
ITC702	Internet of Everything	3	--	3		3
ITDO701X	**Department Optional Course – 3**	**3**	**--**	**3**	**--**	**3**
ITDO702X	**Department Optional Course –4**	**3**	**--**	**3**	**--**	**3**
ITIO701X	**Institute Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL701	Data Science Lab	--	2	--	1	1
ITL702	IOE Lab	--	2	--	1	1
ITL703	Secure Application Development	--	2	--	1	1
ITL704	Recent Open Source Project Lab	--	2	--	1	1
ITP701	Major Project I	--	$6^{\#}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC701	AI and DS –II	20	20	20	80	3	--	--	100
ITC702	Internet of Everything	20	20	20	80	3	--	--	100
ITDO701X	**Department Optional Course –3**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO702X	**Department Optional Course –4**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ILO701X	**Institute Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL701	Data Science Lab	--	--	--	--	--	25	25	50
ITL702	IOE Lab	--	--	--	--	--	25	25	50
ITL703	Secure Application Development	--	--	--	--	--	25	25	50
ITL704	Recent Open Source Project Lab	--	--	--	--	--	25	25	50

ITP701	Major Project I	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

# indicates work load of Learner (Not Faculty), for Major Project

ITDO701X	**Department Optional Course –3**
ITDO7011	Storage Area Network
ITDO7012	High Performance computing
ITDO7013	Infrastructure Security
ITDO7014	Software Testing and QA

ITDO702X	**Department Optional Course –4**
ITDO7021	MANET
ITDO7022	AR – VR
ITDO7023	Quantum Computing
ITDO7024	Information Retrieval System

# Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

ILO701X	**Institute Optional Course – 1 (Common for all branches will be notified)**
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Program Structure for Fourth Year Information Technology Semester VII & VIII

UNIVERSITY OFMUMBAI

(With Effect from2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract. Tut.**	**Theory**	**Pract.**	**Total**
ITC801	Blockchain and DLT	3	--	3	--	3
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL801	Blockchain Lab	--	2	--	1	1
ITL802	Cloud computing	--	2	--	1	1
ITP801	Major Project II	--	$12^{\#}$	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC801	Blockchain and DLT	20	20	20	80	3	--	--	100
ITDO801X	**Department Optional Course – 5**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO802X	**Department Optional Course – 6**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ILO801X	**Institute Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL801	Blockchain Lab	--	--	--	--	--	25	25	50
ITL802	Cloud computing	--	--	--	--	--	25	25	50
ITP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

ITDO801X	**Department Optional Course – 5**
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	**Department Optional Course –6**
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

# Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VIII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

ILO801X	**Institute Optional Course – 2 (Common for all branches will be notified)**
ILO8011	Project Management
ILO8012	Finance Management
ILO8013	Entrepreneurship Development and Management
ILO8014	Human Resource Management
ILO8015	Professional Ethics and CSR
ILO8016	Research Methodology
ILO8017	IPR and Patenting
ILO8018	Digital Business Management
ILO8019	Environmental Management

Program Structure for Fourth Year Information Technology
Semester VII & VIII
UNIVERSITY OFMUMBAI
(**With Effect** from2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	--	3
ITC702	Internet of Everything	3	--	3		3
ITDO701X	**Department Optional Course – 3**	**3**	**--**	**3**	**--**	**3**
ITDO702X	**Department Optional Course –4**	**3**	**--**	**3**	**--**	**3**
ITIO701X	**Institute Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL701	Data Science Lab	--	2	--	1	1
ITL702	IOE Lab	--	2	--	1	1
ITL703	Secure Application Development	--	2	--	1	1
ITL704	Recent Open Source Project Lab	--	2	--	1	1
ITP701	Major Project I	--	$6^{\#}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC701	AI and DS –II	20	20	20	80	3	--	--	100
ITC702	Internet of Everything	20	20	20	80	3	--	--	100
ITDO701X	**Department Optional Course –3**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO702X	**Department Optional Course –4**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO701X	**Institute Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL701	Data Science Lab	--	--	--	--	--	25	25	50
ITL702	IOE Lab	--	--	--	--	--	25	25	50
ITL703	Secure Application Development	--	--	--	--	--	25	25	50
ITL704	Recent Open Source Project Lab	--	--	--	--	--	25	25	50
ITP701	Major Project I	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

# indicates work load of Learner (Not Faculty), for Major Project

ITDO701X	**Department Optional Course –3**
ITDO7011	Storage Area Network
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ILO7011	Product Lifecycle Management
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ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC701	AI and DS –II	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITC701</td><td>AI and DS – II</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To model a decision making for a new problem in an uncertain domain.
2	To demonstrate Cognitive skills of Artificial Intelligence.
3	To become familiar with the basics of Fuzzy Logic and Fuzzy Systems.
4	To become familiar with Deep Learning Concepts and Architectures.
5	To define and apply metrics to measure the performance of various learning algorithms.
6	To enable students to analyze data science methods for real world problems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Design models for reasoning with uncertainty as well as the use of unreliable information.	L1,L2,L3
2	Analyze the process of building a Cognitive application.	L1,L2,L3,L4
3	Design fuzzy controller system.	L1,L2,L3
4	Apply learning concepts to develop real life applications.	L1,L2,L3
5	Evaluate performance of learning algorithms.	L1,L2,L3,L4,L5
6	Analyze current trends in Data Science.	L1,L2,L3,L4

Prerequisite: AI and DS - 1 (ITC604) , Data Mining & Business Intelligence (ITC601)

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Intelligent Agents, Search Techniques, Knowledge and Reasoning, Data Science, Machine Learning.	**02**	--
I	Uncertainty	Uncertainty in AI, Inference using full joint distributions, Bayes Theorem, the semantics of Bayesian Networks, Inference in Bayesian networks, Decision Theory, Markov Decision Processes. **Self-learning Topics:** Hidden Markov Model (HMM), Gaussian Mixture Model (GMM).	**04**	CO1
II	Cognitive Computing	Foundation of Cognitive Computing, Design Principles for Cognitive Systems, Natural Language Processing in Support of a Cognitive System, Representing Knowledge in Taxonomies and Ontologies, Applying Advanced Analytics to Cognitive Computing, The Process of Building a Cognitive Application. **Self-learning Topics:** Cognitive Systems such as IBM's Watson.	**06**	CO2
III	Fuzzy Logic & Its Applications	Introduction to Fuzzy Sets, Properties of Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Membership Functions, Fuzzy Relations with Operations and its Properties, Fuzzy Composition: Max-Min Composition, Max-Product Composition, Defuzzification Methods, Architecture of Mamdani Type Fuzzy Control System, Design of Fuzzy Controllers like Domestic Shower Controller, Washing Machine Controller, Water Purifier Controller, etc. **Self-learning Topics:** Other Fuzzy Composition Operations, Fuzzy Inference System (FIS) & ANFIS.	**07**	CO3
IV	Introduction to Deep Learning	Introduction to Deep Learning, ANN, Machine Learning Vs Deep Learning, Working of Deep Learning; Convolutional Neural Network: Introduction, Components of CNN Architecture, Properties of CNN, Architectures of CNN, Applications of CNN, Recurrent Neural Network: Introduction, Simple RNN, LSTM Implementation, Deep RNN, Autoencoder: Introduction, Features, Types, Applications of Deep Learning. **Self-learning Topics:** Restricted Boltzmann Machine (RBM).	**08**	CO4
V	Advanced ML Classification Techniques	Ensemble Classifiers: Introduction to Ensemble Methods, Bagging, Boosting, Random forests, Improving classification accuracy of Class-Imbalanced Data. Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves. **Self-learning Topics:** Introduction to ML (Revision),	**06**	CO4 CO5

		Introduction to Reinforcement Learning.		
VI	Trends and applications in Data Science	Data Science: applications and case studies, Data science for text, image, video, audio. Data science for Multimodal applications. **Self-learning Topics:** ImageNet Large Scale Visual Recognition Challenge (ILSVRC).	**06**	CO6

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley India, 2015.
3. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, "Deep Learning Using Python", Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, "Introduction to Data Science Practical Approach with R and Python", Wiley India, 2021.
6. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
7. Han J, Kamber M, Pei J, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann.

References:

1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Publication.
2. Ethem Alpaydin , "Introduction to Machine Learning", PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence", Pearson Education.
4. Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://d2l.ai/index.html
2	https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs35/preview
4	https://www.coursera.org/specializations/deep-learning
5	https://onlinecourses.nptel.ac.in/noc22_cs56/preview

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks**.
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.

- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC702	Internet of Everything	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC702	Internet of Everything	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To comprehend Characteristics and Conceptual Framework of IoT.
2	To understand levels of the IoT architectures.
3	To correlate the connection of smart objects and IoT access technologies.
4	To Interpret edge to cloud protocols.
5	To explore data analytics and data visualization on IoT Data.
6	To explore IoT applications.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom’s Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the Characteristics and Conceptual Framework of IoT.	L1,L2
2	Differentiate between the levels of the IoT architectures.	L1,L2,L3,L4
3	Analyze the IoT access technologies.	L1,L2,L3,L4
4	Illustrate various edge to cloud protocol for IoT.	L1,L2,L3
5	Apply IoT analytics and data visualization.	L1,L2,L3
6	Analyze and evaluate IoT applications.	L1,L2,L3,L4

Prerequisite:

1. Python programming
2. C programing language
3. Computer Networks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Ports, Timers ,Programming of controller , How to use IDE to write code of microcontroller, TCP-IP protocol stack	**02**	
I	Introduction to IoT	Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT,Brief review of applications of IoT. Smart Object – Definition, Characteristics and Trends **Self-learning Topics:** Hardware and software development tools for - Arduino, NodeMCU, ESP32, Raspberry Pi, for implementing internet of things, Simulators-Circuit.io,Eagle,Tinkercad	**04**	CO1
II	IoT Architecture	**Drivers Behind New Network Architectures** : Scale,Security,Constrained Devices and Networks ,Data,Legacy Device Support **Architecture :** The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model,Additional IoT Reference Models A Simplified IoT Architecture The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data Versus Network Analytics Data Analytics Versus Business Benefits , Smart Services, **IoT Data Management and Compute Stack** :Fog Computing , Edge Computing ,The Hierarchy of Edge, Fog, and Cloud **Self-learning Topics:** Brief review of applications of IoT: Connected Roadways , Connected Factory, Smart Connected Buildings , Smart Creatures etc,	**06**	CO2
III	Principles of Connected Devices and Protocols in IoT	RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE) roles, LiFi , WPAN std : 802.15 standards: Bluetooth, IEEE 802.15.4, Zigbee, Z-wave, Narrow Band IoT, Internet Protocol and Transmission Control Protocol, 6LoWPAN, WLAN and WAN , IEEE 802.11, Long-range Communication Systems and Protocols: Cellular Connectivity-LTE, LTE-A, LoRa and LoRaWAN.	**08**	CO3
IV	Edge to Cloud Protocol	HTTP, WebSocket, Platforms. HTTP - MQTT - .Complex Flows: IoT Patterns: Real-time Clients, MQTT, MQTT-SN, Constrained Application Protocol (CoAP), Streaming Text Oriented Message Protocol (STOMP), Advanced Message Queuing Protocol (AMQP), Comparison of Protocols.	**08**	CO4

V	IoT and Data Analytics	Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud, Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets, Managing Data lakes, The data retention strategy, visualization and Dashboarding-Designing visual analysis for IoT data, creating a dashboard ,creating and visualizing alerts. **Self-learning Topics:** AWS and Hadoop Technology	**06**	CO5
VI	IoT Application Design	Prototyping for IoT and M2M, Case study related to : Home Automation (Smart lighting, Home intrusion detection), Cities (Smart Parking), Environment (Weather monitoring, weather reporting Bot, Air pollution monitoring, Forest fire detection, Agriculture (Smart irrigation), Smart Library. Introduction to I-IoT, Use cases of the I-IoT,IoT and I-IoT – similarities and differences, Introduction to Internet of Behavior (IoB). **Self-learning Topics:** Internet of Behaviors (IoB) and its role in customer services	**04**	CO6

Text Book

1.Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020
2.David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.
3.Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices.Andrew Minteer,Packet
4.Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

References:
1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC press,
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm, Springer

Online Resources:

Sr. No.	Website Name
1.	https://owasp.org/www-project-internet-of-things/
2.	NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3.	NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview
4.	Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman,Internet of Behaviors (IoB) and its role in customer services,Sensors International,Volume

	2,2021,100122,ISSN 2666-3511,https://doi.org/10.1016/j.sintl.2021.100122

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL701	Data Science Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
ITL701	Data Science Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	Lab Objectives
1	To apply reasoning for a problem in an uncertain domain.
2	To discuss the solution after building a Cognitive application.
3	To familiarize the students with the basics of Fuzzy Logic and Fuzzy Systems.
4	To familiarize the students with Learning Architectures and Frameworks.
5	To define and apply metrics to measure the performance of various learning algorithms.
6	To enable students to analyze data science methods for real world problems.

Lab Outcomes:

Sr. No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Implement reasoning with uncertainty.	L1, L2, L3
2	Explore use cases of Cognitive Computing	L1, L2
3	Implement a fuzzy controller system.	L1, L2, L3
4	Develop real life applications using learning concepts.	L1, L2, L3
5	Evaluate performance of applications.	L1, L2, L3, L4
6	Implement and analyze applications based on current trends in Data Science.	L1, L2, L3, L4, L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM	Python, MySQL or Database Software

3. 500 GB Hard disk	

Prerequisite: Artificial Intelligence and Data Science-I, Python Programming, Data Mining & Business Intelligence.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Uncertainty in AI	1. Implement Inferencing with Bayesian Network in Python	**02**	LO1
II	Cognitive Computing	2. Building a Cognitive Healthcare application 3. Smarter cities: Cognitive Computing in Government 4. Cognitive computing in Insurance 5. Cognitive computing in Customer Service	**04**	LO2
III	Fuzzy Logic & Its Applications	6. Implementation of Fuzzy Membership Functions. 7. Implementation of fuzzy set Properties. 8. Design of a Fuzzy control system using Fuzzy tool.	**04**	LO3
IV	Introduction to Deep Learning	9. Implementing Deep Learning Applications like a. Image Classification System b. Handwritten Digit Recognition System (like MNIST Dataset) c. Traffic Signs Recognition System. d. Image Caption Generator	**06**	LO4
V	Advanced ML Classification Techniques	10. Implementation of supervised learning algorithm like a. Ada-Boosting b. Random forests 11. Evaluation of Classification Algorithms.	**05**	LO4,LO5
VI	Mini-project on trends and applications in Data Science	12. Build text/ image/ video/ audio based DS Applications such as a. Chatbot b. Document Classification c. Sentiment Analysis d. Bounding Box Detection e. Music/Video Genre Classification	**05**	LO6

Text Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive Computing and Big Data Analytics”, Wiley India, 2015.

3. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, “Deep Learning Using Python”, Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, “Introduction to Data Science Practical Approach with R and Python”, Wiley India, 2021.
6. François Chollet, “Deep Learning with Python”, Manning Publications, 2018.
7. Han J, Kamber M, Pei J, “Data Mining Concepts and Techniques”, Third Edition, Morgan Kaufmann.

References:

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Publication.
2. Ethem Alpaydin , “Introduction to Machine Learning”, PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, “Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence”, Pearson Education.
4. Prateek Joshi, “Artificial Intelligence with Python”, Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://wisdomplexus.com/blogs/cognitive-computing-examples/
2	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning_old/labs/explist.php
3	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01329517021676339249401_shared/overview
4	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01329500219268300841860_shared/overview
5	https://www.udemy.com/course/ibm-watson-for-artificial-intelligence-cognitive-computing/

Term Work:

Term Work shall consist of at least 10 practical based on the above list. Also Term Work Journal must include Mini-Project as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiments) + 10 Marks (Mini-project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL702	Internet of Everything Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL702	Internet of Everything Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To learn different types of sensors.
2	To design the problem solution as per the requirement analysis done using sensors.
3	To study the basic concepts of programming/sensors/ emulators.
4	To design and implement the mini project intended solution for project based learning.
5	To build and test the mini project successfully.
6	To improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Identify the requirements for the real world problems.	L1,L2
2	Conduct a survey of several available literatures in the preferred field of study.	L1,L2
3	Study and enhance software/ hardware skills.	L1,L2
4	Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.	L1,L2,L3
5	To report and present the findings of the study conducted in the preferred domain.	L1,L2,L3,L4
6	Demonstrate an ability to work in teams and manage the conduct of the research study.	L1,L2,L3,L4

Hardware & Software requirements:

Hardware Specifications	Software Specifications

PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk 4. Arduino/ Raspberry Pi kit	Python/C, Conitiki, Cooja or any open source Simulator

Prerequisite: Basics of Java and Python Programming, Devops

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Experimentation with Microprocessor and Microcontroller , Experimentation with python and c	**02**	
I	Arduino	Introduction to Arduino, Hardware requirements, Software requirements, Arduino Programming Language, Arduino Uno Wired & Wireless connectivity, LCD commands, Serial Communication commands. Program for blinking LED using Arduino. Traffic Light pattern using Arduino. ESP8266 WiFi Module	**05**	LO1, LO2
II	Raspberry Pi	Introduction to Raspberry Pi, Installation of NOOBS and Raspbian on SD card, Libraries on Raspberry Pi, getting static IP address of Raspberry Pi, Interfacing of Relay, DHT11, DC Motor and LCD with Raspberry Pi.	**05**	LO1,LO2
III	Contiki OS	Contiki OS : History of Contiki OS, Applications, Features, ,Communication Components in Contiki OS, Cooja simulator ,Running Cooja Simulator,	**05**	LO3
IV	Cooja Simulator	Using the Contiki OS with the Cooja simulator to program the IoT for broadcasting data from sensors	**03**	LO5,LO6
V	Protocols and Security with Cooja	Understanding of 6LowPAN , COAP and protocol implementation in Cooja . Encryption Decryption techniques for IoT	**03**	LO5,LO6

VI	IoT data to Cloud	Installing the Remote desktop server. Installation of Pi camera, Face recognition, serial peripheral interface using Raspberry Pi. . DHT11 data logger with ThingSpeak/ thingsboard/ AWS/ Azure server .	**03**	LO4,L06

Text Books:

1. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
4. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga

References:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, Daniel Minoli John Wiley & Sons
3. Contiki Cooja User Guide.
4. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
5. Recent research/white papers

Digital Reference :

1. IoT Analytics -Thingshttps://thingspeak.com
2. https://www.contiki-ng.org/
3. http://www.ideationinstru.com/training.htm

List of Experiments.

Guidelines for Mini Project

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must understand the
    a. Concept
    b. Importance
    c. Interdisciplinary
    d. Challenges
    e. Various applications/smart objects
    f. Major Players/Industry Standards.

4. The students must understand the IoT Architecture:
    a. Node Structure: Sensing, Processing, Communication, Powering
    b. Networking: Topologies, Layer/Stack architecture
    c. Communication Technologies: Introduction to ZigBee, BLE, WiFi, LTE, IEEE 802.11ah, Discuss data rate, range, power, computations/bandwidth, QoS
    d. Smartness - Signal Processing/Analytics: Impact on Power/Energy savings, dynamic networks, simple case studies
    e. IoT Fabricator: Introduction to Embedded electronics, fabricating electronics, Communication Network

requirements, Data processing challenges – recreation, IP/security, Challenges
f. Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android), IoT Fabricator etc. can be used.

5. The students may visit different websites to identify their IOT topic for the mini project.
6. The students may do surveys for different applications using different types of sensors for their mini project.
7. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirements for their mini project problem statement.
8. Design your own circuit board using multiple sensors etc.
9. Installation, configure and manage your sensors in such a way so that they can communicate with each other.
10. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors
11. Create an interface using Mobile/Web to publish or remotely access the data on the Internet.
12. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.
13. Analyze data collected from different sensors on platform like thinkspeak/AWS/Azure etc
14. Devops and Advance Devops concepts students have learnt in earlier semesters can be used while working with IoT projects.
15. Each group may present their work in various project competitions or paper presentations.
16. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Term Work:

Term Work shall consist of Mini-Project based on the above syllabus and guidelines. Also Term Work Journal must include at least 2 assignments.

Term Work Marks:

25 Marks (Total marks) = 15 Marks (Mini-Project) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			**Credits Assigned**			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL703	Secure Application Development	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL703	Secure Application Development	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	**Lab Objectives**
The Lab experiments aims:	
1	To understand the secure programming of application code.
2	To understand the Owasp methodologies and standards.
3	Understand and Identify main vulnerabilities inherent in applications.
4	Understand how Data Validation and Authentication can be applied for application.
5	Understand how to apply Security at Session Layer Management.
6	Understand how to apply to secure coding for cryptography.

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Apply secure programming of application code.	L1,L2,L3
2	Understand the Owasp methodologies and standards.	L1,L2,L3
3	Identify main vulnerabilities inherent in applications.	L1,L2,L3
4	Apply Data Validation and Authentication for application	L1,L2,L3,L4,L5
5	Apply Security at Session Layer Management	L1,L2,L3,L4,L5
6	Apply secure coding for cryptography.	L1,L2,L3,L4,L5

Hardware & Software requirements:

Hardware Specifications	**Software Specifications**
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Web Application, HTML5, CSS3, Java, C, Python, MySQL or Database Software. Internet Connection, Browser, Security tools. SAST tools etc.

- **Prerequisite:**Knowledge of programming languages like java/python/C is required.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	Programming Language and Web application basic concepts.	**02**	
I	Introduction to Secure Programming	Introduction to laws, standards and guidelines of cyber security. What do you mean by attacks, types of attacks and statistics of main vulnerabilities? Lab1: Study of different laws and standards of cyber security.	**04**	LO1
II	Methodologies for developing secure code	Software Development Lifecycle. Risk Analysis. Threat Modeling. Study different SAST (Static Application Security Testing) tools. Study different top 10 methodologies and guidelines of OWASP (Open Web Application Security Project) for the secure application development. Any top 5 OAT. Best eight guidelines for Secure Coding. Understand the flow of Verification testing for secure coding. Lab2: Case study for SDLC. Lab3: Exercise on Threat Modeling. Lab4: Study of SAST Tools (open Source like GitHub, GitLab and so on) and use at least one for practical Lab5: Study and implement at least any 5 methodologies of OWASP. Lab6: Study and implement at least any 5 OAT Denial of Inventory for E-commerce Website..	**06**	LO2
III	VAPT of Applications	Introduction to the HTTP protocol.Owasp Web Security Testing Guidelines. Tools for VAPT testing. Lab7:Use Burp proxy to test web applications.	**04**	LO3
IV	Data Validation & Authentication	Guidelines for input data validation (Data type, Data size, Data range, Data Content etc.) and authentication for login page. Types of Authentication attacks. Study different type of	**05**	LO4

		vulnerabilities like SQL Injection vulnerability, LDAP and XPath Injection vulnerabilities, Cross-Site Scripting (XSS) vulnerability, OS Command, LFI/RFI, Unvalidated file upload and buffer overflow etc. Lab8: Registration Page Data Validation. Lab9: SQL injection vulnerability allows login page to bypass. Lab10: LDAP and XPath Injection vulnerabilities for login /registration page. Lab11: Cross-Site Scripting (XSS) vulnerability Lab Lab12: OS Command vulnerability Lab Lab13: LFI/RFI or Unvalidated file upload or Buffer Overflow vulnerability Lab. Lab14: Online Password attack.		
V	Security in Session Layer	Introduction to Session Layer in Web Applications and management. Session Management Best practices according to OWASP. Lab15: Session Management for Web Application.	**03**	LO5
VI	Secure Coding for cryptography.	Overview of cryptography and guidelines for using encryption. Types of cryptography ie symmetric and asymmetric. Hashing Algorithms etc. Lab16: Symmetric and Asymmetric Lab17: Symmetric Encryption and Hashing.	**02**	LO6

Text & References Books:

1. Fundamental Practice for Secure Software Development.
2. The OWASP Automated Threat Handbook - Web Applications.
3. OWASP Alpha Release Code Review Guide 2.0
4. Secure Programming HOWTO
5. OWASP Quick reference guide 2.

Online References:

Sr. No.	Website Links
1	https://www.udemy.com/course/secure-coding-secure-application-development/
2	https://kirkpatrickprice.com/blog/secure-coding-best-practices/

3	https://owasp.org/www-project-automated-threats-to-web-applications/assets/oats/EN/OAT-021_Denial_of_Inventory

Term Work:

Term Work shall consist of at least 10 to 12 practical based on the above list. Also Term Work Journal must include at least 2 assignments as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiments) + 5 Marks (Assignment) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL704	Recent Open Source Project Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
ITL704	Recent Open Source Project Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	Lab Objectives
The Lab experiments aims:	
1	To understand the basic concepts of Open Source Software.
2	To understand the GPL(General Public Licence) and Contribute of Open Source.
3	To Understand Contribute to Open Source in different Operating System.
4	To Understand Contribute to Open Source in different Technologies.
5	To Understand Contribute to Open Source in different Network Management..
6	To Understand Contribute to Open Source in different Applications and Services.

Lab Outcomes:

Sr. No	Lab Outcomes	Cognitive levels of attainment as per Bloom’s Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and apply the basic concepts of Open Source Software.	L1,L2,L3
2	Identify the difference between the GPL(General Public Licence) and Contributeto Open Source.	L1,L2,L3
3	Apply and evaluate your knowledge for the Contributeto Open Source in different Operating System.	L1,L2,L3,L4,L5
4	Apply and evaluate your knowledge for the Contribute to Open Source in different Technologies.	L1,L2,L3,L4,L5
5	Apply and evaluate your knowledge for the Contribute to Open Source in different Network Management..	L1,L2,L3,L4,L5
6	Apply and evaluate your knowledge for the Contribute to Open Source in different Applications and Services.	L1,L2,L3,L4,L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Internet Connection. Any Operating System. Any technology open source tools/simulator/emulator. Any open source Testing Tools Any open source Network Monitoring Tools. Any open Source Database tools. Any open source Latex report writing tools.

Prerequisite: OS, Programming Language, DBMS, IP, Network.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Concepts of OS, Programming Language, Network and DMBS.	**02**	--
I	Introduction to OSS	Overview of OSS. Basic Concepts of OSS. Advantages of OSS. Difference between free and open source software. What is GPL and Contribute to Open Source Project. Different ways to contribute.	**04**	LO1
II	Contribute to Open Source Project.	Overview of Contribute Open Source Project. Steps or Guidelines of Contribute to Open Source Projects : 1. Why to Contribute to open source Project. 2. What do you mean by Contribute Open Source Projects. 3. Identifying the new/existing open source projects to contribute. 4. Submit your contribute to open source.5. Results after submitting your contribute to Open Source.	**04**	LO2
III	Contribute to Open Source in Operating System.	As per Contribute to Operating System to introduce new OS version, Improve OS by removing bugs, Improve existing Skill sets for growth in career. Interact with Stakeholders for feedback and provide training and mentoring. Start own Startup.	**04**	LO3
IV	Contribute to Open Source in Technologies.	As per Contribute to various emerging technologies like AI/ML/DL/Blockchain/IoT/Data Analytics/Cyber Security/Andriod/iOS/Flutter/DeVoPs/Virtualization and Cloud Computing etc. To improve technologies. Introduce new version of technologies, Improve technologies by removing bugs, Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	**04**	LO4
V	Contribute to Open Source in Network Management.	As per Contribute to different types of Network and Management Systems like LAN/WAN/MAN/Adhoc Network/Data Centre/Wireless Network/Enterprise	**04**	LO5

		Network etc. To improve Networks as a Network administrator. Design own Network as per customer requirements, Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.		
VI	Contribute to Open Source in Application & Cloud Services.	As per Contribute to various Applications or Case studies using Cloud Services etc. To improve applications, remove bugs. Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	**04**	LO6

Guidelines for Recent Open Source Mini Project as per above syllabus.

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement how to contribute to open source mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of recent contribute to open source mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand contribute to open source problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report using open source tools to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the open source Mini Projects.

Guidelines for Assessment of Recent Open Source Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual’s contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book : 10
  - Marks awarded by review committee : 10
  - Quality of Project Report :05

Text& Reference Books:

1. Forge Your Future with Open Source: Build Your Skills. Build Your Network. Build the Future of Technology. 1st Edition

Online References:

Sr. No.	Website Links
1	https://github.com/freeCodeCamp/how-to-contribute-to-open-source
2	https://opensource.guide/how-to-contribute/#why-contribute-to-open-source

Term Work:

Term Work shall consist of at least Open Source Project based on the above syllabus. Also Term Work Journal must include at least 2 assignments to explain contribute to open source as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini-Project) + 5 Marks (Assignment) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – I	--	06	--	--	03	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM701	Major Project – I	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project-I and major project-II.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project-I & IIactivity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VIIand Major Project-IIin semesters VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or motivate for Copyright or Indian Patent as an extension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Major Project:
Term Work

1. The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester VII and VIII.
2. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
3. Distribution of Term work marks for both semesters shall be as below;
    a. Marks awarded by guide/supervisor based on log book : 10
    b. Marks awarded by review committee : 10
    c. Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.

One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem and proposed solution of the problem
    - Second shall be on readiness of working and testing of prototypeto be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
    - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
    - Second review shall be based on paper presentation in conference/journal or copyright or Indian patent in last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

1. Quality of survey/ need identification

2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7011	Storage Area Network	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO7011	Storage Area Network	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide the knowledge of types Storage Network.
2	To examine NAS technology and its applications in Storage Area Networks.
3	To study Emerging Technologies in SAN.
4	To define backup, recovery, disaster recovery and business continuity in the storage area Network.
5	To learn cloud based storage virtualization technologies in SAN.
6	To understand the logical and physical components of storage infrastructures.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the limitations of the client-server architecture and evaluate the need for data protection and storage centric architectures such as Intelligent storage system.	L1,L2
2	Understand various SAN technologies.	L1,L2
3	Interpret and examine NAS technologies and its application in Storage Area Network.	L1,L2
4	Explain Different I/O Techniques in SAN.	L1,L2
5	DescribeCloud based storage virtualization technologies in SAN.	L1,L2
6	Explain Storage infrastructure management with security.	L1,L2

Prerequisite: Operating System, Computer Organization, Computer Networks.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Components of a Storage System Environment, Disk drive components, RAID levels, Cloud Computing	**02**	**--**
I	Introduction to Storage Area Network	**Intelligent Storage Systems (ISS)**, Storage Provisioning, Types of Intelligent Storage Systems **Evolution of Storage System:** Server-Centric IT Architecture and its Limitations, Storage-Centric IT Architecture and its Advantages, SAN & its advantages. **Self-learning Topics:** Case Study on Replacing a server with Storage networks**.**	**04**	CO1
II	Networked Attached Storage & its Application	**Local File Systems:** File systems and databases,Journaling, Snapshots,Volume manager **Network File Systems, and File Servers:** Network Attached Storage (NAS), Performance bottlenecks in file servers, Acceleration of network file systems, Case study: The Direct Access File System (DAFS), **Shared Disk File Systems:** A case study The General Parallel File System (GPFS), **Applying NAS solution:** NAS workload characterization, applying NAS to departmental workloads, enterprise web workloads, and specialized workloads; Considerations when integrating SN and NAS: Differences and similarities, the need to integrate, future storage connectivity and integration. **Self-learning Topics:** Case study on Successful SAN Deployment steps**.**	**07**	CO2
III	Storage I/O Techniques	The Physical I/O Path from the CPU to the Storage System, SCSI, The Fibre Channel Protocol Stack, Fibre Channel SAN, IP Storage, Infiniband-based Storage Networks, Fibre Channel over Ethernet (FCoE). **Self-learning Topics: C**ase Study on FCoE SAN.	**06**	CO3
IV	Backup and Data Archive	**Introduction to Business Continuity:** Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis **Backup and Archive:** Backup Purpose, Backup Considerations, Backup Granularity,	**06**	CO4

		Recovery Considerations, Backup Methods ,Backup Architecture, Backup and Restore Operations, Backup Topologies **Self-learning Topics:** Case Study on Replication strategy		
V	Storage Area Network as a Service for Cloud Computing & Virtualization	**Virtualization and the cloud:** Cloud infrastructure virtualization, Cloud platforms, Storage virtualization, SAN virtualization **Virtualization Appliances:** Black Box Virtualization, In-Band Virtualization Appliances, Out-of-Band Virtualization Appliances High Availability for Virtualization Appliances, Appliances for Mass Consumption. **Storage Automation and Virtualization:** Policy-Based Storage Management, Application-Aware Storage Virtualization, Virtualization-Aware Applications. **Self-learning Topics:** Case study on symmetric and asymmetric virtualization in networks.	**06**	CO5
VI	Securing and Managing storage infrastructure	**Securing and Storage Infrastructure:** Information Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking, Securing Storage Infrastructure in Virtualized and Cloud Environments. **Managing the Storage Infrastructure:** Monitoring the Storage Infrastructure, Storage Infrastructure Management activities, Storage Infrastructure Management Challenges, Information Lifecycle Management, Storage Tiering **Self-learning Topics:** Case study on SAN Management and Standards**.**	**08**	CO6

Text Books:

1. G. Somasundaram, Alok Shrivastava, EMC Educational Services, “Information Storage and Management”, Wiley India.
2. Storage Virtualization, Author: Clark Tom, Publisher: Addison Wesley Publishing Company
3. Ulf Troppens, Wolfgang Muller-Friedt, Rainer Wolafka, “Storage Networks Explained” Wiley Publication
4. "Introduction to Storage Area Networks" Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel, Libor Miklas, IBM Redbooks.

References:

1. Richard Barker and Paul Massiglia, ìStorage Area Network Essentials: A Complete Guide to Understanding and Implementing SANsî, Wiley India.
2. Storage Networks: The Complete Reference, by Robert Spalding(Author)
3.“Storage Network Management and Retrieval”, Vaishali Khairnar, Nilima Dongre. Wiley

Online References:

1. https://www.itprc.com/ultimate-guide-to-storage-area-networks/
2. https://www.techtarget.com/searchstorage/definition/storage-area-network-SAN
3. https://www.snia.org/educational-library/object-storage-trends-use-cases-2021
4. https://www.sciencedirect.com/topics/computer-science/network-attached-storage
5. https://www.techtarget.com/searchstorage/tip/Understand-your-storage-infrastructure-management
6. https://sites.google.com/site/testwikiforfirstciscolab/shd/14-securing-the-storage-infrastructure
7. https://www.techtarget.com/searchdatabackup/tip/What-is-the-difference-between-archives-and-backups

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7012	High Performance Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7012	High Performance Computing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Learn the concepts of high-performance computing.
2	Gain knowledge of platforms for high performance computing.
3	Design and implement algorithms for parallel programming applications.
4	Analyze the performance metrics of High Performance Computing.
5	Understand the parallel programming paradigm, algorithms and applications.
6	Demonstrate the understanding of different High Performance Computing tools.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand fundamentals of parallel Computing.	L1,L2
2	Describe different parallel processing platforms involved in achieving High Performance Computing.	L1,L2,L3
3	Demonstrate the principles of Parallel Algorithms and their execution.	L1,L2,L3
4	Evaluate the performance of HPC systems.	L1,L2,L3,L4
5	Apply HPC programming paradigm to parallel applications.	L1,L2,L3
6	Discuss different current HPC Platforms.	L1,L2

Prerequisite: Computer Organization, C Programming, Data structures and Algorithm Analysis.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Organization, C Programming, Data structures and Algorithm Analysis.	**02**	--
I	Introduction	**Introduction to Parallel Computing:** Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation). **Self-learning Topics:** Parallel Architectures: Interconnection network, Processor Array, Multiprocessor.	**05**	CO1
II	Parallel Programming Platforms	**Parallel Programming Platforms:** Implicit Parallelism: Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines. **Self-learning Topics:** Trends in Microprocessor & Architectures, Limitations of Memory System Performance.	**04**	CO2
III	Parallel Algorithm And Concurrency	**Principles of Parallel Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Basic Communication operations: Broadcast and Reduction Communication types. **Self-learning Topics: Parallel Algorithm Models**	**09**	CO3
IV	Performance Measures for HPC	**Performance Measures:** Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law. **Self-learning Topics:** Performance Bottlenecks.	**05**	CO4
V	Programming Paradigms for HPC	**Programming Using the Message-Passing Paradigm :** Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding. **Parallel Algorithms and Applications :** One-Dimensional Matrix-Vector Multiplication, Graph Algorithms, Sample Sort, Two-Dimensional Matrix Vector Multiplication. **Self-learning Topics:** Introduction to OpenMP.	**09**	CO5

VI	General Purpose Graphics Processing Unit(GPGPU) Architecture and Programming	OpenCL Device Architectures, Introduction to OpenCL Programming. **Self-learning Topics:** Introduction to CUDA architecture, and Introduction to CUDA Programming.	**05**	CO6

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPU Programming", Addison-Wesley Professional ©, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
5. Benedict Gaster, Lee Howes, David Kaeli, Perhaad Mistry, Dana Schaa , "Heterogeneous Computing with OpenCL" , 2nd Edition, Elsevier, 2012.

References Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.
4. Fayez Gebali, "Algorithms and Parallel Computing", John Wiley & Sons, Inc., 2011.

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_cs46/preview
2.	https://onlinecourses.nptel.ac.in/noc22_cs21/preview

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical /Oral**	**Tutorial**	**Total**
ITDO7013	Infrastructure Security	03	--	-	03	--	-	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test1	**Test 2**	**Avg. of 2 Tests**					
ITDO7013	Infrastructure Security	20	20	20	80	-	-	-	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To understand underlying principles of infrastructure security.
2	To explore software vulnerabilities, attacks and protection mechanisms to learn security aspects of wireless network infrastructure and protocols.
3	To investigate web server vulnerabilities and their countermeasures.
4	To investigate cloud infrastructure vulnerabilities and their countermeasures.
5	To learn the different attacks on Open Web Applications and Web services.
6	To learn the different security policies.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom’s Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of vulnerabilities, attacks and protection mechanisms.	L1,L2
2	Analyze and evaluate software vulnerabilities and attacks on databases and operating systems.	L1,L2,L3
3	Explain the need for security protocols in the context of wireless communication.	L1,L2,L3
4	Understand and explain various security solutions for Cloud infrastructure.	L1,L2
5	Understand, and evaluate different attacks on Open Web Applications and Web services.	L1,L2
6	Design appropriate security policies to protect infrastructure components.	L1,L2,L3

Prerequisite: Computer Networks, Cryptography and Network Security

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of OSI Model, Topology's and Computer Networks, Cryptography and Network Security.	**02**	**--**
I	Introduction	Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC,MAC, RBAC, ABAC, BIBA, Bell La Padula), **Self-Learning Topics:** Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	**04**	CO1
II	Software Security	**Software Vulnerabilities:** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits **Operating System Security:** Memory and Address Protection, File Protection Mechanism, UserAuthentication. **Database Security:** Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security **Self-Learning Topics:** Format String, File System Security (Windows and Linux OS)	**08**	CO2
III	Wireless Security	Mobile Device Security- Security Threats, Device Security, IEEE 802.11xWireless LAN Security, VPN Security, Wireless Intrusion Detection System (WIDS) **Self-Learning Topics:** Wireshark, Cain and Abel, Aircrack.	**06**	CO3
IV	Cloud Security	Cloud Security Risks and Countermeasures, Data Protection in Cloud, Cloud Application Security, Cloud Identity and Access Management, Cloud Security as a Service. **Self-Learning Topics:** Metasploit, Ettercap.	**06**	CO4

V	Web Security	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross- Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, DNS Attacks, Web Service Security, Secure Electronic Transaction, Email Attacks, Web Server Security as per OWASP, Firewalls. **Self-Learning Topics:** Penetration Testing tools: SQL Map, Wapiti.	**08**	CO5
VI	Information Security and Risk Management	Security Policies, Business Continuity Plan, Risk Analysis, Incident Management, Legal System and Cybercrime, Ethical Issues in Security Management. **Self-Learning Topics:** The Indian IT Act, Indian Cyber Law	**05**	CO6

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

References Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O'Riely
6. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7014	Software Testing and QA	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITDO7014</td><td>Software Testing and QA</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide students with knowledge in Software Testing techniques.
2	To provide knowledge of Black Box and White Box testing techniques.
3	To provide skills to design test case plans for testing software.
4	To prepare test plans and schedules for testing projects.
5	To understand how testing methods can be used in a specialized environment.
6	To understand how testing methods can be used as an effective tool in providing quality assurance concerning software.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	L1, L2, L3
2	Understand various software testing methods and strategies.	L1, L2
3	Manage the testing process and testing metrics.	L1, L2, L3
4	Understand fundamental concepts of software automation and use automation tools.	L1, L2
5	Apply the software testing techniques in the real time environment.	L1, L2. L3
6	Use practical knowledge of a variety of ways to test software and quality attributes.	L1, L2

Prerequisite: Programming Language (C++, Java), Software Engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering Concepts, Basics of programming Language	**02**	

I	Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology, Verification and Validation, Verification requirements, Verification of high level design, Verification of low level design, validation. **Self-learning Topics:** Study any system/application, find requirement specifications and design the system. Select software testing methodology suitable to the application.	**07**	CO1
II	Testing Techniques	Dynamic Testing: Black Box Testing: Boundary Value Analysis, Equivalence Class Testing, State Table Based testing, Cause-Effect Graphing Based Testing, Error Guessing. White Box Testing Techniques: need, Logic Coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing, Data Flow testing, Mutation testing. Static Testing. Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, Regression Testing, Regression Testability, Objectives of Regression Testing, Regression Testing Types, Define Problem, Regression Testing Techniques. **Self-learning Topics:** Select the test cases (positive and negative scenarios) for the selected system and Design Test cases for the system using any two studied testing techniques.	**09**	CO2
III	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and test Specification. Software Metrics: need, definition and Classification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding metrics, estimation model for testing effort, architectural design, information flow matrix used for testing, function point and test point analysis. Efficient Test Suite Management: minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization its type , techniques and measuring effectiveness.	**08**	CO3

		Self-learning Topics: Design quality matrix for your selected system		
IV	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium etc. **Self-learning Topics:** Write down test cases, execute and manage using studied tools	**05**	CO4
V	Testing for specialized environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, traditional software and web based software, challenges in testing for web based software, testing web based testing **Self-learning Topics:** Study the recent technical papers on software testing for upcoming technologies (Mobile, Cloud, Blockchain, IoT)	**04**	CO5
VI	Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO9000:2000, SIX sigma, Software quality management **Self-learning Topics:** Case Studies to Identify Quality Attributes Relationships for different types of Applications (Web based, Mobile based etc.)	**04**	CO6

Text Books:

1.Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy , Wiley Publication

References Books:

1.Effective Methods for Software Testing , third edition by Willam E. Perry, Wiley Publication
2. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , Dreamtech press

Online References:
1. www.swayam.gov.in
2. www.coursera.org
3. http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099 -1689
4.https://onlinecourses.nptel.ac.in/noc17_cs32/preview
5. https://www.youtube.com/channel/UC8w8_H_1uDfi2ftQx7a64uQ

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

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- A total of **four questions** need to be answered.

Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical/ Oral**	**Tutorial**	**Total**
ITDO7021	Theory Course	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITDO7021</td><td>Mobile Ad-hoc Network</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To identify and distinguish major issues associated with ad-hoc networks.
2	To analyze the basic concepts for designing a routing protocol for MANETs.
3	To explore and analyze routing protocols of Ad-hoc network.
4	To learn the concepts of Transport layer and Security issues for MANETs.
5	To apply fundamental principles characteristics of QoS and understand the need of Energy Management in wireless ad-hoc network.
6	To learn the basic concepts of Sensor Networks for Communication in Mobile Ad-hoc network.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the fundamentals of Mobile ad-hoc Networks.	L1,L2
2	Understand and be able to use advanced concept of MAC layer protocols more effectively.	L1,L2
3	Analyse different routing technologies for designing a routing protocol.	L1,L2,L3,L4

4	Understand the concepts of Transport layer and security features of Ad-hoc network.	L1,L2
5	Create the awareness of QoS and Energy Management in Ad hoc network.	L6
6	Demonstrate the ability of wireless sensor network.	L2,L3,L4

Prerequisite: Wireless Technology.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of Wireless Communication, Wireless Metropolitan and Local Area Networks: IEEE 802.16 (WiMax) – Mesh mode, IEEE 802.11(Wi-Fi) – Architecture, Wireless Ad hoc Networks: WPAN Device Architecture, Wireless Sensor Network Applications, Advantages and Limitations, Wireless Network Security: Security in GSM; UMTS Security; Bluetooth Security; WEP.	**02**	**--**
I	Introduction to Ad-hoc Wireless Networks	Introduction: Cellular and Ad Hoc Wireless Networks, Applications of Ad Hoc Wireless Networks, Issues In Ad Hoc Wireless Networks: Medium Access Scheme, Routing, Multicasting, Transport Layer Protocols, Pricing, Quality of Service Provisioning, Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations, Ad Hoc Wireless Internet **Self-learning Topics:** Global Mobile Ad Hoc Network Market	**05**	CO1
II	Medium Access Control Protocols	Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols with Reservation Mechanisms and Scheduling Mechanisms, IEEE 802.11a and HiperLan standard **Self-learning Topics:** MAC Protocols that use Directional Antennas and Other MAC Protocols	**07**	CO2
III	Routing Protocols	**Routing Protocols inAd-hoc Wireless Networks:** Introduction, Design issues, Classification of Routing Protocols: Routing information update mechanism, Use of temporal information for routing, Routing topology, Utilization of specific resources, **Multicast Routing in Ad-hoc Wireless Networks**: Introduction, Design Issues, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols **Self-learning Topics:** Table Driven Routing Protocols, Classifications of Multicast Routing Protocols	**08**	CO3
IV	Transport Layer and Security Protocols	**Transport Layer in Ad-hoc Wireless Networks**: Introduction, Design Issues and Goals of a Transport Layer Protocol; Classification of Transport Layer Solutions. **Security in Ad-hoc Wireless Networks:** Issues and	**07**	CO4

		Challenges in Security Provisioning, Network Security Attacks classification. **Self-learning Topics:** TCP over Transport Layer Solutions, Key Management and Secure Touting		
V	Quality of Service and Energy Management	**Quality of Servicein Ad-hoc Wireless Networks**: Introduction, Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions **Energy ManagementinAd-hoc Wireless Networks**: Introduction, Need for Energy Management in Ad-hoc Wireless Networks, Classification of Energy Management Schemes **Self-learning Topics:** MAC Layer Solutions Battery Management Schemes	**06**	CO5
VI	Wireless Sensor Networks	Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering **Self-learning Topics:** Location Discovery and Quality of a Sensor Network	**04**	CO6

Text Books:

1. C. S. Ram Murthy, B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols",
Prentice Hall of India, 2nd Edition, 2005
2. C. K. Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 2002
3. Wireless Communications & Networks, By William Stallings, Second Edition, Pearson Education

References Books:

1. Shih-Lin Wu Yu-Chee Tseng, "Wireless Ad Hoc Networking: Personal-Area, Local-Area, and the Sensory-Area Networks", Auerbach Publications, 2007
2. Subir Kumar Sarkar, "Adhoc Mobile Wireless Network: Principles, Protocols and Applications" CRC Press
3. Prashant Mohapatra and Sriramamurthy, "Ad Hoc Networks: Technologies and Protocols", Springer International Edition, 2009

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

Assessment:
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- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7022	ARVR	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
ITDO7022	ARVR	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concepts of Augmented Reality and related technologies.
2	To understand the AR tracking system and use of computer vision in AR/MR.
3	To describe the technology for multimodal user interaction and authoring in AR.
4	To understand primitives of computer graphics fundamental.
5	To analyze various Hardware devices suitable for VR.
6	To analyze visual physiology and issues related to it.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and compare different Augmented Reality and Mixed Reality Technologies.	L1, L2
2	Apply concepts of Computer Vision for tracking in AR and MR Systems.	L3
3	Model different interfaces and authoring in AR/MR.	L3
4	Solve Computer Graphics Problems.	L1
5	Analyze application of VR hardware and software components.	L1, L2, L3
6	Identify issues related to visual physiology.	L1, L2

Prerequisite: Programming Language, Computer Graphics, Virtual Reality

DETAILED SYLLABUS:

Module	Title	Description	Hours	CO
0	Pre-requisite	Basics of Computer Graphics, Coordinate Systems, VR Introduction, Tracking in VR	**02**	--
I	Introduction to Augmented Reality and Mixed Reality	Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality **Self-Learning Topics**: How AR/MR are related to Ubiquitous Computing, Multidimensional Systems.	**04**	CO1
II	Tracking and	Multimodal Displays; Visual Perception; Spatial Display Model;	**06**	CO2

	Computer Vision for AR and MR	Visual Displays; Tracking, Calibration and Registration; Coordinate Systems; Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking; Multiple Camera Infrared Tracking; Natural Feature Tracking by Detection; Incremental Tracking; Simultaneous Localization and Tracking; Outdoor Tracking **Self-Learning Topics**: Indoor Tracking, Full Body Tracking		
III	Interaction, Modeling and Annotation and Authoring	Output Modalities, Input Modalities, Tangible Interfaces, Virtual User Interfaces on Real Surfaces, Multi-view Interfaces, Haptic Interaction, Multimodal Interaction, Specifying Geometry, Specifying Appearance, Semi-automatic Reconstruction, Free-form Modeling, Annotation, Requirement of AR Authoring, Elements of Authoring, Stand-alone Authoring Solutions, Plug-in Approaches, Web Technology **Self-Learning Topics**: Case Study on Object Annotation in Real Time, Avatar Modeling.	**06**	CO3
IV	Geometry of Virtual World	Geometric Modeling, 2D transformations, Homogenous coordinate system, 3D rotation and 6 degree of freedom, Viewport Transformation **Self:** Eye Transformation, demo of 2D transformation	**08**	CO4
V	Introduction to VR	Introduction to VR and definitions and its components., Hardware components: Display devices: LCD, OLED Audio: Speakers, Earphones, Bone conduction Touch: Haptic Device GPU and CPU, Input devices like game controller, data glows, Joysticks Tracking Hardware: Industrial measurement Unit-IMU, Gyroscope, accelerometer Software component: Java3D, VRML **Self:** Feedback mechanisms in VR environment	**07**	CO5
VI	Visual Physiology, perception and tracking	Functioning of Eye with photoreceptors, Resolution for VR, Eye movements and issues with it in VR, Neuroscience of vision, Depth and motion perception, Frame rates and display, Orientation tracking, tilt and yaw drift correction, Tracking with camera **Self:** Light House approach	**06**	CO6

Textbooks:

1. Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition.
2. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
3. Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.
4. **.** Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002.
5. **.** R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018.
6. . Steven M. LaVelle," Virtual Reality", Cambridge University press, 2019
7. **.** Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley India, 2003
8. **.** Vince, "Virtual Reality Systems", 1st Edition, Pearson Education, 2002

References Books:

1. Borko Furht, "Handbook of Augmented Reality", Springer, 2011 Edition.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing, 2013 Edition.
4. George Mather, "Foundations of Sensation and Perception", Psychology Press book; 3rd Edition, 2016
5. Tony Parisi, " Learning Virtual Reality", 1st edition, O'Reilly, 2015
6. Alan Craig and William Sherman," Understanding virtual reality: Interface, application and design", 2nd Edition, Morgan Kaufmann Publisher, 2019
7. Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of Computer Graphics" ,A K Peters/CRC Press; 4th Edition, 2016.

Online Resources:

Sr. No.	**Website Name**
1.	www.nptel.ac.in
2.	www.coursera.org
3.	https://nptel.ac.in/courses/121/106/121106013/#
4.	http://msl.cs.uiuc.edu/vr/
5.	http://lavalle.pl/vr/

Assessment:

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- A total of **four questions** need to be answered.

Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical /Oral**	**Tutorial**	**Total**
ITDO7023	Quantum Computing	03	--	--	03	--	--	03

Course Code	**Course Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test1	**Test2**	**Avg. of 2 Tests**					
ITDO7023	Quantum Computing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	**Course Objectives**
The course aims:	
1	To know the fundamentals of Quantum computing and its applications.
2	To understand the efficient quantum algorithms for several basic promise problems.
3	To gain knowledge about quantum computers and their principles.
4	To understand the principles, quantum information and limitation of quantum operations formalizing.
5	To gain knowledge about different quantum error and its correction techniques.
6	To gain knowledge about different quantum cryptographic algorithms.

Course Outcomes:

Sr. No.	**Course Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Basics of Quantum computing and its applications.	L1,L2
2	Solve various problems using quantum algorithms.	L1,L2
3	Methodology for quantum computers and their principles.	L1,L2,L3
4	Comprehend quantum noise and operations.	L1,L2,L3
5	Gain knowledge about different quantum error correction techniques.	L1,L2,L3
6	To gain knowledge about different quantum cryptographic algorithms.	L1,L2,L3

Prerequisite: NA

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
I	FUNDAMENTALS OF QUANTUM	Fundamental Concepts: Introduction and Overview – Global Perspectives – Quantum Bits – Quantum Computation – Quantum Algorithms – Experimental Quantum Information	**07**	**CO1**

	COMPUTING	Processing – Quantum Information. Problems on Qubits **Self-learning Topics:** Detail ofQuantum computing and its applicationshttps://www.ibm.com/quantum-computing/what-is-quantum-computing/		
II	QUANTUM COMPUTATION	Quantum Circuits – Quantum algorithms, Single Orbit operations, Control Operations, Measurement, Universal Quantum Gates, Simulation of Quantum Systems, Quantum Fourier transform, Phase estimation, Applications, Quantum search algorithms – Quantum counting – Speeding up the solution of NP – complete problems – Quantum Search for an unstructured database. Problems on Boolean functions and Quantum gates, Quantum gates and circuits. **Self-learning Topics:** Application of Quantum Computing	**08**	CO2
III	QUANTUM COMPUTERS	Guiding Principles, Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer – Optical cavity Quantum electrodynamics, Ion traps, Nuclear Magnetic resonance. **Self-learning Topics:** Qiskit	**06**	CO3
IV	QUANTUM INFORMATIONS	Quantum noise and Quantum Operations – Classical Noise and Markov Processes, Quantum Operations, Examples of Quantum noise and Quantum Operations – Applications of Quantum operations, Limitations of the Quantum operations formalism, Distance Measures for Quantum information. Problems on Measurement **Self-learning Topics:**Case study on Quantum noise and operations.	**07**	CO4
V	QUANTUM ERROR CORRECTION	Introduction, Shor code, Theory of Quantum Error –Correction, Constructing Quantum Codes, Stabilizer codes, Fault – Tolerant Quantum Computation. **Self-learning Topics:**Case study on Quantum error correction.	**05**	CO5
VI	QUANTUM CRYPTOGRAPHY	Quantum Cryptography-Private Key Cryptography, Privacy Amplification and Information Reconciliation, Quantum Key Distribution, Privacy and Coherent Information, The Security of Quantum Key Distribution. Problems on Quantum error correction and cryptography. **Self-learning Topics:** Attacks on Quantum Cryptography	**06**	CO6

Text Books:

1. Chris Bernhardt,” Quantum Computing for Everyone”, (The MIT Press) Hardcover – Illustrate ,September 2020,
2. Willi-Hans Steeb; “Problems and Solutions in Quantum Computing and Quantum Information”, Yorick Hardy Academic Consulting and Editorial Services (ACES) Private Limited, January 2020.
3. M.A. Nielsen and I.Chuang,“Quantum Computation and Quantum Information”, Cambridge University Press 2010.

References Books:

1. Computer Science: An Introduction by N. DavidMermin 5. Yanofsky's and Mannucci, Quantum Computing for Computer Scientists.
2. Parag K. Lala ,Quantum Computing: A Beginner's Introduction Paperback” , McGraw Hill November 2020.
3. V. Sahni, “Quantum Computing”, Tata McGraw-Hill Publishing company,2007.
4. Nayak, Chetan; Simon, Steven; Stern, Ady; Das Sarma, Sankar, “NonabelianAnyons and Quantum Computation”, 2008.

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

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Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical/ Oral**	**Tutorial**	**Total**
ITDO7024	Information Retrieval System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7024	Information Retrieval System	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the fundamentals of the information retrieval system.
2	To classify various Information retrieval models.
3	To demonstrate the query processing techniques and operations.
4	To compare the relevance of query languages for text and multimedia data.
5	To evaluate the significance of various indexing and searching techniques for information retrieval.
6	To develop an effective user interface for information retrieval.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define and describe the objectives of the basic concepts of the Information retrieval system.	L1,L2
2	Evaluate the taxonomy of different information retrieval models.	L1,L2,L3,L4
3	Try to solve and process text and multimedia retrieval queries and their operations.	L1,L2
4	Evaluate text processing techniques and operations in the information retrieval system.	L1,L2,L3,L4
5	Demonstrate and evaluate various indexing and searching techniques.	L1,L2,L3,L4
6	Design the user interface for an information retrieval system.	L1,L2,L3,L4

Prerequisite: Data Structures

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Indexing and searching Algorithms**	**02**	
I	Introduction	Motivation, Basic Concepts, The Retrieval Process, Information System: Components, parts and types on	**06**	CO1

		information system; Definition and objectives on information retrieval system, Information versus Data Retrieval. Search Engines and browsers **Self-learning Topics:** Search Engines , Search API		
II	IR Models	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Formal Characteristics of IR models, Classic Information Retrieval, Alternative Set Theoretic models, Probabilistic Models, Structured text retrieval Models, models for Browsing; **Self-learning Topics:** Terrier	**06**	CO2
III	Query Processing and Operations	Query Languages: Keyword based Querying, Pattern Matching, Structural Queries, Query Protocols; Query Operations: User relevance feedback, Multimedia IR models: Data Modeling **Self-learning Topics:** Proximity Queries and Wildcard Queries	**06**	CO3
IV	Text Processing	Text and Multimedia languages and properties: Metadata, Markup Languages, Multimedia; Text Operations: Document Preprocessing, Document Clustering. **Self-learning Topics:** Digital Library : Greenstone	**06**	CO4
V	Indexing and Searching	Inverted files, Other indices for text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression; Multimedia IR: Indexing and Searching:- A Generic Multimedia indexing approach, , Automatic Feature extraction; Searching Web: Challenges, Characterizing the web, Search Engines. Browsing, Meta searches, Searching using Hyperlinks. **Self-learning Topics:** Koha	**07**	CO5
VI	User interface and visualization	Human Computer interaction, the information access process, starting points, query specifications, context, using relevance judgments, interface support for the search process. **Self-learning Topics:** SeeSoft	**06**	CO6

Text Books:

1. Modern Information Retrieval, Ricardo Baeza-Yates,berthier Ribeiro- Neto, ACM Press- Addison Wesley
2. Information Retrieval Systems: Theory and Implementation, Gerald Kowaski, Kluwer Academic Publisher
3. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India.

References Books:

1. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press.
2. Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
3. Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman.

Online References:

1. https://www.geeksforgeeks.org/what-is-information-retrieval/
2. https://nlp.stanford.edu/IR-book/
3. https://en.wikipedia.org/wiki/Information_retrieval
4. https://people.ischool.berkeley.edu/~hearst/irbook/10/node1.html

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- A total of **four questions** need to be answered.

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Course Objectives: Students will try :

1. To familiarize the students with the need, benefits and components ofPLM
2. To acquaint students with Product Data Management & PLMstrategies
3. To give insights into new product development program and guidelines for designing and developing aproduct
4. To familiarize the students with Virtual ProductDevelopment

Course Outcomes: Students will be able to :

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDMimplementation.
2. Illustrate various approaches and techniques for designing and developingproducts.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal workingetc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturingplant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLMApplications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

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4. Only Four question need to besolved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN:1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN:0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN:3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probabilitytheory
2. To acquaint the students with reliability and itsconcepts
3. To introduce the students to methods of estimating the system reliability of simple and complexsystems
4. To understand the various aspects of Maintainability, Availability and FMEAprocedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineeringproblems
2. Apply various reliability concepts to calculate different reliabilityparameters
3. Estimate the system reliability of simple and complexsystems
4. Carry out a Failure Mode Effect and CriticalityAnalysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, ReliabilityFunctions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair VsReplacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four question need to besolved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd.,1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGrawHill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons,1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons,1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley &Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co.Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technicalfield.
2. Discuss the roles played by information technology in today’s business and define various technology architectures on which information systems arebuilt
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitiveadvantage
4. Identify the basic steps in systemsdevelopment

Outcomes: Learner will be able to…

1. Explain how information systems TransformBusiness
2. Identify the impact information systems have on anorganization
3. Describe IT infrastructure and its components and its currenttrends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decisionmaking
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value forbusinesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational andAnalytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasivecomputing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

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4. Only Four question need to besolved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems,Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the DigitalFirm, 10th Ed., Prentice Hall,2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall,2008

Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments(DOE)
2. To list the guidelines for designingexperiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness andoptimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real lifesituations
3. Plan, analyze, and interpret the results ofexperiments

Module	Detailed Contents	Hrs
01	**Introduction** Strategy ofExperimentation Typical Applications of ExperimentalDesign Guidelines for DesigningExperiments Response SurfaceMethodology	06
02	**Fitting Regression Models** Linear Regression Models Estimation of the Parameters in Linear RegressionModels Hypothesis Testing in MultipleRegression Confidence Intervals in MultipleRegression Prediction of new responseobservation Regression modeldiagnostics Testing for lack offit	08
03	**Two-Level Factorial Designs** The 2^2Design The 2^3Design The General2^kDesign A Single Replicate of the 2^kDesign The Addition of Center Points to the 2^kDesign, Blocking in the 2^k FactorialDesign Split-PlotDesigns	07
04	**Two-Level Fractional Factorial Designs** The One-Half Fraction of the 2^kDesign The One-Quarter Fraction of the 2^kDesign The General 2^{k-p} Fractional FactorialDesign Resolution III Designs Resolution IV and VDesigns Fractional Factorial Split-PlotDesigns	07

05	**Response Surface Methods and Designs** Introduction to Response SurfaceMethodology The Method of SteepestAscent Analysis of a Second-Order ResponseSurface Experimental Designs for Fitting ResponseSurfaces	07
06	**Taguchi Approach** Crossed Array Designs and Signal-to-NoiseRatios AnalysisMethods Robust designexamples	04

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End Semester Theory Examination:

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4. Only Four question need to besolved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York,2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley &Sons, New York,2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed.Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN:0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean,and D.T.Voss

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programmingmodel.
2. Understand the mathematical tools that are needed to solve optimizationproblems.
3. Use mathematical software to solve the proposedmodels.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementaryslackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the datachange.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flowproblems.
4. Understand the applications of integer programming and a queuing model and compute important performancemeasures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**:Introduction, , Structure of the Mathematical Model, Limitations of OperationsResearch **Linear Programming**:Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation ofLPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODImethod. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling SalesmanProblem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts,	05

	Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04	**Dynamic programming**. Characteristics of dynamic programming.Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

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End Semester Theory Examination:

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REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition,2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath RamNath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand &Sons.

Course Code	Course Name	Credits
ILO7016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyberlaw
2. To recognized Indian IT Act 2008 and its latestamendments
3. To learn various types of security standardscompliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outsideworld
2. Interpret and apply IT law in various legalissues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design anddevelopment

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

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REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security,* Wiley India, NewDelhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House NewDelhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, NewDelhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, NewDelhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* PearsonPublication
8. Websites for more information is availableon: The Information Technology ACT, 2008- TIFR :https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional :https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals- 33538

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around theworld
2. To identify extent and damaging capacity of adisaster
3. To study and understand the means of losses and methods to overcome /minimizeit.
4. To understand role of individual and various organization during and afterdisaster
5. To understand application of GIS in the field of disastermanagement
6. To understand the emergency government response structures before, during andafter disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previoushistory.
3. Get acquainted with government policies, acts and various organizational structure associated with anemergency.
4. Get to know the simple do's and don'ts in such extreme events and actaccordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozonedepletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences ofmanmade disasters.	09
03	Disaster Management, Policy and Administration Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy andadministration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to startwith and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Managementof	06

	casualties, set up of emergency facilities, importance of effective communication amongst different agencies in suchsituations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in thisregard.	
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO’s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO’s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach theseteams. International relief aid agencies and their role in extremeevents.	09
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning andcommunication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingencyplans. Do’s and don’ts in case of disasters and effective implementation ofrelief aids.	06

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REFERENCES:

1. ‘Disaster Management’ by Harsh K.Gupta, Universities PressPublications.
2. ‘Disaster Management: An Appraisal of Institutional Mechanisms in India’ by O.S.Dagur, published by Centre for land warfare studies, New Delhi,2011.
3. ‘Introduction to International Disaster Management’ by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. ‘Disaster Management Handbook’ by Jack Pinkowski, CRC Press Taylor and Francisgroup.
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, NewDelhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic websites)

Course Code	Course Name	Credits
ILO7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energyconservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energymanagement
3. To relate the data collected during performance evaluation of systems for identification of energy savingopportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and itsimportance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation ofsome common electrical installations and identify the energy savingopportunities.
4. To describe the energy performance evaluation ofsome common thermal installations and identify the energy savingopportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act- 2001 and its Features. Basics of Energy and its various forms, Materialand Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

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4. Only Four question need to besolved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, BlackwellScience
2. Designing with light: Lighting Handbook, By Anil Valia, LightingSystem
3. Energy Management Handbook, By W.C. Turner, John Wiley andSons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute(TERI).
5. Energy Management Principles, C.B.Smith, PergamonPress
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRCPress
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	**Development Engineering**	**03**

Objectives:

1. To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of ruralDevelopment
2. To provide an exposure toimplications of 73rdCAA on Planning, Development and Governance of RuralAreas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indianprofessionals
4. To familiarise the Nature and Type of Human Values relevant to PlanningInstitutions

Outcomes: Learner will be able to…

1. Demonstrateunderstanding of knowledge for RuralDevelopment.
2. Prepare solutions for ManagementIssues.
3. Take up Initiatives and design Strategies to complete thetask
4. Develop acumen for higher education andresearch.
5. Demonstrate the art of working in group of differentnature
6. Develop confidence to take up rural project activitiesindependently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	**06**
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	**07**

4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including -XI schedule, devolution of powers, functions and finance; Panchayati Rajinstitutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love andwisdom	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of thecurriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only **Four questions need to besolved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, NewDelhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication,Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, NewDelhi
4. Planning Commission, Five Year Plans, PlanningCommission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide toBeginners
7. Weaver, R.C., The Urban Complex,Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association,Washington

9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp.123-150
10. Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 –407

Program Structure for Fourth Year Information Technology
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC801	Blockchain and DLT	3	--	3	--	3
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL801	Blockchain Lab	--	2	--	1	1
ITL802	Cloud computing	--	2	--	1	1
ITP801	Major Project II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC801	Blockchain and DLT	20	20	20	80	3	--	--	100
ITDO801X	**Department Optional Course – 5**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO802X	**Department Optional Course – 6**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO801X	**Institute Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL801	Blockchain Lab	--	--	--	--	--	25	25	50
ITL802	Cloud computing	--	--	--	--	--	25	25	50
ITP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

ITDO801X	**Department Optional Course – 5**
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	**Department Optional Course –6**
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

ILO801X	**Institute Optional Course – 2 (Common for all branches will be notified)**
ILO8011	Project Management
ILO8012	Finance Management
ILO8013	Entrepreneurship Development and Management
ILO8014	Human Resource Management
ILO8015	Professional Ethics and CSR
ILO8016	Research Methodology
ILO8017	IPR and Patenting
ILO8018	Digital Business Management
ILO8019	Environmental Management

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC801	Blockchain and DLT	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC801	Blockchain and DLT	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To get acquainted with the concept of Distributed ledger system and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain through the Bitcoin network.
3	To understand Ethereum and develop-deploy smart contracts using different tools and frameworks.
4	To understand permissioned Blockchain and explore Hyperledger Fabric.
5	To understand different types of crypto assets.
6	To apply Blockchain for different domains IOT, AI and Cyber Security.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Blockchain and Distributed Ledger Technology.	L1,L2
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions	L1,L2,L3
3	Implement smart contracts in Ethereum using different development frameworks.	L1,L2,L3
4	Develop applications in permissioned Hyperledger Fabric network.	L1,L2,L3
5	Interpret different Crypto assets and Crypto currencies	L1,L2,L3
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.	L1,L2,L3,L4

Prerequisite: Cryptography and Distributed Systems.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Cryptography and Distributed Systems (prerequisite)	Hash functions, Public – Private keys, SHA, ECC, Digital signatures, Fundamental concepts of Distributed systems	**02**	—-

I	Introduction to DLT and Blockchain	Introduction to Blockchain: Technical definition of Blockchain. Elements of a blockchain Features of Blockchain Type of Blockchain, What is DLT . DLT V/S BlockchainCAP theorem Byzantine Generals Problem Consensus Mechanism and its TypeCryptographic primitives and data structure used in blockchain **Block in a Blockchain**: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree. **Self-learning Topics:** Blockchain Demo	**04**	CO1
II	Bitcoin	What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, UTXO. validation of transactions, Bitcoin Keys , Addresses, ECC , Base58 , BIP-38 , Pay-to Script and Multisig Addresses, Vanity Addresses , Concept of Wallet, Wallet Technologies in Bitcoin HD wallet from Seed. Transaction Scripts and Scripts address,Bitcoin Mining and Difficulty levels Structure of Blocks and Blockheader and Genesis Block , linking of Block. **Bitcoin Network**: Bitcoin Core node and API, Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging “Inventory”, Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks Bitcoin TestnetBasics of Bitcoin Forensics: Analysis of Address and Wallet , Clustering of Addresses following Money **Self-learning Topics:** Study and compare different consensus algorithms like PoA, PoS, pBFT	**08**	CO2
III	Permissionless Blockchain: Ethereum	Introduction to Ethereum, Ethereum 1.0 and 2.0 , Turing completeness EVM and compare with bitcoinBasics of Ether Units, Ethereum Wallets Working with Metamask EOA and Contracts Transaction:: Structure of Transaction, Transaction Nonce, Transaction GAS, Recipient, Values and Data, Transmitting Values to EOA and Contracts **Smart Contracts and Solidity** Development environment and client , Basic of Solidity and Web 3Life cycle of Smart contract, Smart Contract programming using solidity, Metamask (Ethereum Wallet), Setting up development environment, Use cases	**10**	CO3

		of Smart Contract, Smart Contracts: Opportunities and Risk. **Smart Contract Deployment**: Introduction to Truffle, Use of Remix and test networks for deployment **Self-learning Topics:** Smart contract development using Java or Python		
IV	Permissioned Blockchain: Hyperledger Fabric	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain. **Components**: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFTDesigning Hyperledger BlockchainOther Challenges : Interoperability and Scalability of blockchain **Self-learning Topics:** Fundamentals of Hyperledger Composer	**07**	CO4
V	Crypto assets and Cryptocurrencies	ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, NFT, ICO, STO, Different Crypto currencies **Self-learning Topics:** Defi, Metaverse, Types of cryptocurrencies	**04**	CO5
VI	Blockchain Applications & case studies	Blockchain in IoT, AI, Cyber Security **Self-learning Topics:** Applications of Blockchain in various domains Education, Energy, Healthcare, real-estate, logistics, supply chain	**04**	CO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
5. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
6. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.

Reference Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing 2. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
2. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley.
3. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them, Antony Lewis. for Ethereum and Blockchain, Ritesh Modi, Packt publication.

4. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media

Online References:

1. NPTEL courses:
    a. Blockchain and its Applications,
    b. Blockchain Architecture Design and Use Cases
2. www.swayam.gov.in/
3. www.coursera.org
4. https://ethereum.org/en/
5. https://www.trufflesuite.com/tutorials
6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h
7. Blockchain demo: https://andersbrownworth.com/blockchain/
8. Blockchain Demo: Public / Private Keys & Signing: https://andersbrownworth.com/blockchain/public-private-keys/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

		Teaching Scheme (Contact Hours)			**Credits Assigned**			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL801	Blockchain Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL801	Blockchain Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr.No	**Lab Objectives**
1	To develop and deploy smart contracts on local Blockchain.
2	To deploy the smart contract on test networks.
3	To deploy and publish smart contracts on Ethereum test network.
4	To design and develop crypto currency.
5	To deploy chain code on permissioned Blockchain.
6	To design and develop a Full-fledged DApp using Ethereum/Hyperledger.

Lab Outcomes:

Sr.No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom’s Taxonomy**
1	Develop and test smart contract on local Blockchain.	L3,L4
2	Develop and test smart contract on Ethereum test networks.	L3,L4
3	Write and deploy smart contract using Remix IDE and Metamask.	L4
4	Design and develop Cryptocurrency.	L4
5	Write and deploy chain code in Hyperledger Fabric.	L4
6	Develop and test a Full-fledged DApp using Ethereum/Hyperledger.	L5

Prerequisite: Programming Langauges.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	Java, Python, JavaScript	**02**	—
I	Local Blockchain	Introduction to Truffle, establishing local Blockchain using Truffle Mini Project: Allocation of the groups	**02**	LO1
II	Smart contracts and	Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local	**04**	LO2

	Chain code	Blockchain Mini Project: Topic selection		
III	Deployment and publishing smart contracts on Ethereum test network	Ethereum Test networks (Ropsten/Gorelli/Rinkeby), deployment on test networks, Web3.js/Web3.py for interaction with Ethereum smart contract Mini Project: Topic validation and finalizing software requirements	**04**	LO3
IV	Remix IDE and Metamask	Smart contract development and deployment using Metamask and Remix Design and develop Crypto currency Mini Project: Study the required programming language for smart contract	**04**	LO4
V	Chain code deployment in Hyperledger Fabric	Chain code deployment in Hyperledger fabric Mini project: Study required front end tools	**04**	LO5
VI	Mini-project on Design and Development of a DApps using Ethereum/Hyperledger Fabric	Implementation of Mini Project 1. Design, configure and testing of mini project 2. Report submission as per guidelines	**06**	LO6

Mini project:

1. Students should carry out mini-project in a group of three/four students with a subject In-charge
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, develop and test their smart contract/chain code.
6. Each group may present their work in various project competitions and paper presentations

Documentation of the Mini Project

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Technology/platform used)
5. Chapter-2 (System design/Block diagram, Flow chart, Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Ethereum Smart Contract Development, Mayukh Mukhopadhyay, Packt publication.
2. Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication.

3. Hands-on Smart Contract Development with Hyperledger Fabric V2, Matt Zand, Xun Wu and Mark Anthony Morris, O'Reilly.

References Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing
2. Introducing Ethereum and Solidity, Chris Dannen, APress.
3. Hands-on Blockchain with Hyperledger, Nitin Gaur, Packt Publishing.

Online References:

1. https://trufflesuite.com/
2. https://metamask.io/
3. https://remix.ethereum.org/
4. https://www.hyperledger.org/use/fabric

Term-Work: Term-Work shall consist of 5 experiments and Mini-Project on above guidelines/syllabus. Also, Term-work must include at least 2 assignments and Mini-Project report.
Term Work Marks: 25 Marks (Total marks) =15 Marks (5 Experiments + Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL802	Cloud Computing	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
ITL802	Cloud Computing	--	--	--	--	25	25	50

Lab Objectives:

Sr.No	Lab Objectives
1	Tomakestudents familiarwith keyconceptsof virtualization.
2	Tomakestudentsfamiliarwithvariousdeploymentmodelsofcloudsuchasprivate,public,hybridandcommunity.
3	To understand the usingandadoptingappropriatetypeofcloudfor theirapplication.
4	TomakestudentsfamiliarwithvariousservicemodelssuchasIaaS,SaaS,PaaS,Securityas aService(SECaaS)andDatabaseasaService.
5	Apply the different service models for the application.
6	Tomakestudents familiar with securityand privacyissues in cloudcomputingandhow to addressthem.

Lab Outcomes:

Sr.No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Implementdifferenttypesofvirtualizationtechniques.	L1,LL3,L4
2	Analyzevariouscloudcomputingservicemodelsandimplementthemtosolvethegivenproblems.	L1,L2,L3,L4
3	Design anddeveloprealworldwebapplicationsanddeploythemoncommercialcloud(s).	L6
4	Explainmajorsecurityissues in thecloud and mechanisms toaddress them.	L1,L2,L3
5	Explorevariouscommerciallyavailablecloudservicesandrecommendtheappropriateoneforthegivenapplication.	L1,L2,L3
6	Implementtheconceptofcontainerization.	L1,L2,L3

Prerequisite: Programming Langauges, DBMS.

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	DBMS, Programming Language.	**02**	—
I	Overview& Virtualization.	Introductionandoverviewofcloudcomputing. HostedVirtualizationusingKVM. Lab1: TostudyandimplementHostedVirtualizationusingVirtual Box &KVM. Lab2: To study and Implement Bare-metal Virtualization usingXen,HyperVor VMwareEsxi.	**04**	LO1
II	Infrastructure Services.	To study the infrastructure services using different cloud platform Lab3: To study and Implement Infrastructure as a Service usingAWS/MicrosoftAzure/Google cloud platform	**04**	LO2
III	Platform Services	To study the different platform services. Lab4: To study and Implement Platform as a Service usingAWSElasticBeanstalk/Microsoft AzureApp Service.	**03**	LO3
IV	Cloud Services	IaaS,PaaS,STaaS,DbaaS,IAMandSecurity as a Service on AWS andAzure. Lab5: Tostudyand Implement SecurityasaServiceonAWS/Azure. Lab6: TostudyandimplementIdentityandAccessManagement(IAM)practices onAWS/Azurecloud.	**04**	LO4
V	Storage Services	To study the storage services using Docker. Lab7: To study and Implement Storage as a Service using OwnCloud/AWSS3, Glaciers/ AzureStorage. Lab8: Tostudyand Implement DatabaseasaServiceonSQL/NOSQLdatabaseslike AWSRDS,AZURESQL/MongoDBLab/Firebase. Lab9: To study and Implement Containerization using Dockeron AWS/Azure/Google cloud platform**.**	**04**	LO5
VI	Kubermetes	Introduction and overview of Kubernetes. Lab10: To study and implement container orchestration usingKubernetes on AWS/Azure/Google cloud platform	**05**	LO6

Textbooks:	
1	BernardGolden,“AmazonWeb ServicesforDummies”,JohnWiley&Sons,Inc.
2	MichaelCollier,RobinShahan,“Fundamentalsof Azure,MicrosoftAzureEssentials”, MicrosoftPress.
3	RajkumarBuyya,ChristianVecchiola,SThamaraiSelvi,“MasteringCloudComputing”, TataMcGraw-HillEducation.
4	BarrieSosinsky, “CloudComputingBible”,Wileypublishing.
5	JohnPaulMueller,“AWSforAdminsfor Developers”,JohnWiley&Sons,Inc.
6	KenCochrane,JeevaS.Chelladhurai,NeependraKhare, “DockerCookbook-Second Edition”,Packtpublication
7	JonathanBaier,“GettingStartedwithKubernetes-SecondEdition”,PacktPublication.

Online References:

1. https://phoenixnap.com/kb/ubuntu-install-kvm\
2. NIST Cloud Computing Security Reference Architecture
3. https://docs.citrix.com/en-us/xenserver/7-1/install.html
4. https://docs.aws.amazon.com
5. https://docs.microsoft.com/en-us/azure
6. https://docs.docker.com/get-started/
7. https://kubernetes.io/docs/home/

Term-Work: Term-Work shall consist of 10 experiments on above guidelines/syllabus. Also, Term-work must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) =15 Marks (Experiments) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the syllabus.

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – II	--	12	--	--	06	--	06

Course Code	**Course Name**	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM701	Major Project – II	--	--	--	--	100	50	150

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project-I and major project-II.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project -I & II activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VIIand Major Project-II in semesters VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or Copyright or Patent as an extension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Major Project:
Term Work

1. The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester VII and VIII.
2. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
3. Distribution of Term work marks for both semesters shall be as below;
   a. Marks awarded by guide/supervisor based on log book : 10
   b. Marks awarded by review committee : 10
   c. Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.

One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalization of problem and proposed solution of the problem
  - Second shall be on readiness of working and testing of prototypeto be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
  - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
  - Second review shall be based on paper presentation in conference/journal or motivate for copyright or Indian patent in last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

14. Quality of survey/ need identification
15. Clarity of Problem definition based on need.
16. Innovativeness in solutions
17. Feasibility of proposed problem solutions and selection of best solution
18. Cost effectiveness
19. Societal impact
20. Innovativeness
21. Cost effectiveness and Societal impact
22. Full functioning of working model as per stated requirements
23. Effective use of skill sets
24. Effective use of standard engineering norms
25. Contribution of an individual's as member or leader
26. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8011	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8011	Big Data Analytics	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To provide an overview of an exciting growing field of Big Data analytics.
2	To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3	To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4	To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5	To introduce to the students several types of big data like social media, web graphs and data streams.
6	To enable students to have skills that will help them to solve complex real-world problems in decision support.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the motivation for big data systems and identify the main sources of Big Data in the real world.	L1,L2,L3
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store, retrieve and process Big Data for Analytics.	L1,L2,L3
3	Implement several Data Intensive tasks using the Map Reduce Paradigm.	L1,L2,L3
4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data.	L1,L2,L3
5	Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.	L6
6	Design and implement successful Recommendation engines for enterprises.	L6

Prerequisite: AI and DS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Data Mining, Data Science	**02**	
I	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications **Self-learning Topics:** Identification of Big Data applications and its solutions	**03**	CO1
II	Introduction to Big Data Frameworks	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Working with Apache Spark What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, MongoDB **Self-learning Topics:**HDFS vs GFS, MongoDB vs other NoSQL system, Implementation of Apache Spark	**06**	CO2
III	MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step . Illustrating use of MapReduce with use of real life databases and applications. **Self-learning Topics:**Implementation of MapReduce algorithms like Word count, Matrix-Vector and Matrix-Matrix algorithm	**07**	CO3
IV	Mining Big Data Streams	The Stream Data Model: A DataStream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk, Motwani Algorithm, Query Answering in the DGIM Algorithm. **Self-learning Topics:** Streaming services like Apache Kafka/Amazon Kinesis/Google Cloud DataFlow. Standard spark streaming library. Integration with IOT devices to capture real time stream data.	**07**	CO4
V	Big Data Mining Algorithms	Frequent Pattern Mining : Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Overview SVM classifiers, Parallel SVM, KNearest Neighbor classifications for Big Data, One Nearest Neighbour. **Self-learning Topics:** Standard libraries included with spark like graphX, MLlib	**07**	CO5

VI	Big Data Analytics Applications	**Link Analysis :** PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. **Mining Social- Network Graphs :** Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. **Recommendation Engines:** A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering **Self-learning Topics:** Sample applications like social media feeds, multiplayer game interactions, retail industry, financial data analysis. Use case like location data, real-time stock trades, log monitoring etc	**07**	CO6

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press.
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
4. Rajkumar Buyya, ,Rodrigo N. Calheiros and Amir Vahid Dastjerdi, "Big Data Principles and Paradigms", Morgan Kaufmann

References Books:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications

Online References:

1. https://nptel.ac.in/courses/106/104/106104189/
2. https://nptel.ac.in/courses/106106142/
3. https://nptel.ac.in/courses/106105186/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDO8012	Reinforcement Learning	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITDO8012</td><td>Reinforcement Learning</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr.No	Course Objectives
1	Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.
2	Introduce to statistical learning techniques where an agent explicitly takes actions and interacts with the world.
3	Implement in code common RL algorithms.
4	Describe multiple criteria for analyzing RL algorithms & evaluate algorithms on these metrics: e.g. regret, sample complexity, computational complexity, empirical performance, convergence, etc.
5	Know how to implement dynamic programming as an efficient solution approach to an industrial control problem.
6	Explore solutions to the Exploration-Exploitation Dilemma.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Learn how to define RL tasks and the core principles behind the RL, including policies, value functions, deriving Bellman equations.	L1,L2
2	Evaluate work with tabular methods to solve classical control problems.	L1,L2,L3
3	Apply Markov Decision Processes to solve real-world problems.	L1,L2,L3
4	Understand the dynamic programming for policy Evaluation.	L1,L2
5	Implement reinforcement learning problems based on averaging sample returns using Monte Carlo method.	L1,L2,L3
6	Recognize current advanced techniques and applications in RL.	L1,L2,L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Probability distributions and expected values, and basic linear algebra (e.g., inner products).	**02**	
I	Introduction to Reinforcement Learning:	**Reinforcement Learning**: Key features and Elements of RL, Types of RL, rewards. **Reinforcement Learning Algorithms**: Q-Learning, State Action Reward State Action (SARSA), **Self-learning Topics:** Deep Q Neural Network (DQN)**,** Applications of RL	**04**	CO1
II	Bandit problems and online learning:	An n-Armed Bandit Problem, Action-Value Methods Tracking a Nonstationary Problem, Optimistic Initial Values Upper-Confidence-Bound Action Selection Gradient Bandits **Self-learning Topics:** Associative Search (Contextual Bandits)	**07**	CO2
III	Markov Decision Processes:	The Agent–Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, Value Functions and Optimal Value Functions, **Self-learning Topics:** Optimality and Approximation	**07**	
IV	Dynamic Programming:	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration **Self-learning Topics:**	**07**	CO4
V	Monte Carlo Methods and Temporal-Difference Learning	Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, TD Prediction, TD control using Q-Learning **Self-learning Topics:** Off -policy Prediction via Importance Sampling	**07**	CO5
VI	Applications and Case Studies	Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling **Self-learning Topics:** Study of applications.	**05**	CO6

Text Books:

1. Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2. Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement Learning Workshop: Learn how to Apply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, 2020 Packt publishing.
3. Phil Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly
4. Dr Engr S M Farrukh Akhtar, Practical Reinforcement Learning, Packt Publishing, 2017.

References Books:

1. Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, value iteration, policy gradients, TRPO, AlphaGo Zero.
2. Csaba Szepesv´ari, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers
3. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson Education, Inc.

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**
    - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
    - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8013	Theory Course	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO8013	Simulation and Modeling	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To introduce the discrete event simulation systems.
2	To discuss the modeling techniques of entities, queues, resources and entity transfers in the discrete event environment.
3	To formulate and apply the statistical models in simulation and queuing theory.
4	To gain knowledge of random numbers, random variates and various statistical tests on random numbers.
5	To formulate and build valid models and perform simulation analysis of the system and analyze results properly.
6	To familiarize with various applications of Simulation.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the meaning of simulation and Identify the common applications of discrete-event system simulation.	L1,L2
2	Practice formulation and modeling skills.	L1,L2,L3
3	Analyze events and inter-arrival time, arrival process, queuing strategies, resources and disposal of entities using statistical models.	L1,L2,L3,L4
4	Understand pseudo-random numbers and perform statistical tests to measure the quality of pseudo-random numbers.	L1,L2
5	Apply different distributions to fit the collected data and describe the process of verification and validation of simulation models.	L1,L2,L3
6	Describe various applications of simulation.	L1,L2

Prerequisite: Probability and Statistics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Probability: Probability mass function, Probability density function, Mean, Variance, Median, Mode	**02**	-
I	Introduction to Simulation	SimulationDefinition, When Simulation is an appropriate tool and when it is not, Advantages and disadvantages of simulation, Areas of application of simulation, System and its types, Models and its types, Steps in simulation study **Self-learning Topics:** Monte Carlo simulation	**04**	CO1
II	Simulation Examples and General Principles	Simulation Process, Simulation of Single-server and multi-server queueing systems, Simulation of (M, N) Inventory and Newspaper Seller Problem, Simulation of Lead-time Demand Concepts in Discrete Event Simulation, Event Scheduling Algorithm, Manual Simulation of Single Server and Dump Truck Problem using Event Scheduling Algorithm **Self-learning Topics:** Simulation of Reliability Problem, Process Interaction Approach in Simulation.	**08**	CO2
III	Mathematical ,Statistical and Queueing Models in Simulation	Statistical Models: Terminology and concepts, Useful statistical models, Discrete Distributions (Bernoulli's trial, Binomial and Negative Binomial, Poisson Distributions), Continuous Distributions (Exponential, Uniform, Erlang, Triangular and Normal Distributions), Poisson Process, Queueing Models: Queuing Notations, Long Run Performance Measures, M/M/1 and M/G/1 Queueing Systems **Self-learning Topics:**	**08**	CO3
IV	Random Numbers and Variates	Random Number Generation: Why are random numbers required in simulation? Properties of random numbers, Linear Congruential Method to generate Random Numbers, Test for Uniformity: Kolmogorov-Smirnov, Chi-Square, Test for Independence: Runs up and runs down, Runs above and below mean, Poker test), Random Variate Generation: Inverse Transform Technique, Direct Transformation for Normal and Lognormal distribution, Acceptance Rejection Technique **Self-learning Topics:** Tests for Autocorrelation	**08**	CO4
V	Analysis of Simulation Data	Steps in Input Modeling, Goodness-of-fit tests, Selecting Input Model without data, Multivariate and Time Series Models,Model Building verification and validation,Verification of simulation models, Naylor and Finger Approach for calibration and Validation of simulation models **Self-learning Topics:** Input-Output Validation: Using Historical Input Data	**06**	CO5

VI	Applications of Simulation	High-Level Computer-System Simulation and Memory Simulation, Simulation of Manufacturing and Material Handling Systems **Self-learning Topics:** Simulation of Computer Networks	**03**	CO6

Text Books:

1. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 3rd Ed., Prentice-Hall.
2. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 4th Ed., Prentice-Hall.

References Books:

1. A. M. Law and W. D. Kelton (2000), Simulation Modeling and Analysis, 4th Ed., McGraw Hill.
2. K. S. Trivedi (2001), Probability and Statistics with Reliability, Queuing and Computer Science Applications, Eastern Economy Edition, Prentice-Hall (India).
3. Banks C M, Sokolowski J A, Principles of Modeling and Simulation, Wiley
4. Geoffrey Gordon, System Simulation, EEE
5. Narsing Deo, System Simulation with Digital Computer; PHI

Online References:

1. https://www.udemy.com/course/discrete-event-system-simulation/
2. https://www.tutorialspoint.com/modelling_and_simulation/index.htm

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8014	Knowledge Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8014	Knowledge Management	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits, and guiding principles on which to build greater understanding of knowledge management.
2	Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.
3	Increase information and understanding about knowledge transfer using low- and high technology strategies.
4	Explore the future of knowledge management and its influence on our jobs, communities, and society.
5	Explore different tools for knowledge codification and knowledge transfer.
6	Discuss impact of knowledge management on product, people and organization, etc. with qualitative and quantitative measures.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.	L1,L2,L3
2	Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems.	L1,L2,L3
3	Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.	L4,L5
4	Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy Ponder KM's current and future impact on individuals, organizations and society at large.	L1,L2,L3
5	Apply different tools for knowledge transfer and Business Intelligence in knowledge sharing.	L1,L2,L3
6	Analyze different modes of knowledge conversion and testing tools for knowledge codification.	L1,L2,L3,L4

Prerequisite: An introductory course in IT/ IS

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**CO Mapping**
0	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge -Subjective & Objective views of knowledge, procedural Vs. declarative, tacit Vs. explicit, general Vs. specific.	**02**	
I	Introduction to Knowledge Management	What is Knowledge? Data, information and knowledge, Knowledge management process, Types of expertise – associational, motor skill, theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity, Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role, Relevance of KM in today's dynamic & complex environment, Future of Knowledge Management **Self-Learning Topics:** Study the various KM process.	**07**	**CO1**
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation, Knowledge Architecture. **Self-Learning Topics:** Case study for KMSLS.	**06**	**CO2**
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies, Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory Grid- Concept Mapping –Blackboarding, Nominal Group Technique, Delphi method. **Self-Learning Topics:** Study various technologies used in KM in industry.	**06**	**CO5**
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer's Skill Sets – System Testing and Deployment – Knowledge Testing –Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation. **Self-Learning Topics:** Study different tools for testing for KM.	**06**	**CO6**
V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers. **Self-Learning Topics:** Case study for transfer methods in KM.	**06**	**CO3**
VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures, Identification of appropriate	**06**	**CO4**

		KM solutions, Competing with Business Analytics, Caveats for managing Knowledge and Business Intelligence, Corporate social Responsibility, Ethical Legal and Managerial Issues: PAPA, Security and controls. **Self-Learning Topics:** Case study on KM impact.		

Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies. Prentice Hall. ISBN: 0-13-109931-0.
2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13- 034820-1
3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).
4. Shelda Debowski, Knowledge Management, Wiley India Edition
5. Keri E Pearlson, Carol S. Saunders, Strategic Management of Information System, Wiley India Edition
6.

References Books:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.
2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.
3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.
4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.

Online resources:

1. https://onlinecourses.nptel.ac.in/noc19_mg33/preview
2. https://www.udemy.com/course/knowledge-management/
3. https://www.coursehero.com/file/70272191/km-pdf-imppdf/
4. http://cs.unibo.it/~gaspari/www/teaching/slides_KM6.pdf

Assessment:

Internal Assessment (IA) for 20 marks:

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- **Question paper format**

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    - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8021	User Interface Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8021	User Interface Design	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To stress the importance of good interface design.
2	To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.
3	To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.
4	To learn the techniques for prototyping and evaluating user experiences.
5	To understand interaction design process and evaluate design.
6	To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom’s Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and criticize bad features of interface designs.	L1,L2,L3
2	Predict good features of interface designs.	L1,L2,L3
3	Illustrate and analyze user needs and formulate user design specifications.	L1,L2,L3
4	Interpret and evaluate the data collected during the process.	L1,L2,L3
5	Evaluate designs based on theoretical frameworks and methodological approaches.	L1,L2,L3,L4,L5
6	Apply better techniques to improve the user interaction design interfaces.	L1,L2,L3

Prerequisite: Software Engineering.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering concepts and any programming Language **Self-learning Topics:** Web design languages	**02**	NA
I	Introduction to Interaction Design	Good and Poor Design, What is Interaction Design, The User Experience, The Process Of Interaction Design, Interaction Design and the User Experience, Necessity of UI/UX **Self-learning Topics:** Study of Various interactive day to day application	**05**	CO1
II	Understanding and Conceptualizing Interaction Cognitive aspects and Social, Emotional Interaction	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types, Cognitive aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies **Self-learning Topics:** Study of Various interactive Interface Types	**05**	CO2
III	Data Gathering, Establishing Requirements, Analysis, Interpretation and Presentation	Establishing Requirements, Five Key Issues, Techniques for Data Gathering, Data Analysis Interpretation and Presentation, Task Description and Task Analysis **Self-learning Topics:** Any case study of how to gather requirements .(eq.BE Project)	**08**	CO3
IV	Process of Interaction Design, Prototyping, Construction.	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies **Self-learning Topics:** Study of two websites with usability concepts.	**07**	CO4 / CO5
V	Design rules and Industry standards	Design principles, Principles to support Usability, Standards and Guidelines, Golden rules and Heuristics, ISO/IEC standards .The 15 Rules Every UI/UX Designer Should Know . **Self-learning Topics:** Study experiments on industry standards and design principles. principles.https://xd.adobe.com/ideas/career-tips/15-rules-every-ux-designer-know/	**07**	CO5

VI	Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, case studies, DECIDE Framework, Usability Testing, conducting experiments, Field studies, Heuristic Evaluation and walkthroughs, Predictive models. **Self-learning Topics:** Evaluation of any GUI with usability principles.	**05**	CO5/ CO6

Text Books:

1. Interaction Design, by J. Preece, Y. Rogers and H. Sharp. ISBN 0-471-49278-7.
2. Human Computer Interaction, by Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.

References Books:

1. The UX Book, by Rex Hartson and Pardha S Pyla
2 **.**Donald A. Norman, “The design of everyday things”, Basic books.
3. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
4. UI Design: Key to captivate User Understanding, by Nilakshi Jain, Dhananjay Kalbande

Online References:

1. https://onlinecourses.nptel.ac.in/noc21_ar05/preview
2. https://nptel.ac.in/courses/124/107/124107008/
3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ar10/
4. https://nptel.ac.in/courses/107/103/107103083/
5. https://www.youtube.com/watch?v=6C2Ye1makdY&list=PLW-zSkCnZ-gD5TDfs1eL5EnH2mQ0f9g6B
6. https://xd.adobe.com/ideas/process/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8022	Robotics	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITDO8022</td><td>Robotics</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr.No.	Course Objectives
1	Learn the basic concepts of Robot.
2	Learn the concepts of Kinematics of Robotics.
3	Learn the different types of Actuators and Sensors in Robot Designing.
4	Learn the concepts of Motions, Velocities and Dynamic Analysis of Force.
5	Learn the concepts of Trajectory and Motion Planning.
6	Learn the different Programming Languages to program Robot.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand different types of robot, its characteristics and applications.	L1,L2
2	Analyse kinematics parameters of robotic manipulator.	L1,L2,L3,L4
3	Identify actuators, sensors and control of a robot for different applications.	L1,L2,L3
4	Apply the differential relationships of motion, velocities and dynamic analysis of force.	L1,L2,L3
5	Apply the concept of trajectory and motion planning in robot programming.	L1,L2,L3
6	Use robot programming languages and acquire skills to program robots.	L1,L2,L3

Prerequisite: Mathematical concepts of Geometry, Linear Algebra, Calculus, Basic Electronics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Homogenous Coordinate System, Matrix Representation and its Operations, Vector	**02**	--

		Algebra: Dot and Cross Products, Orthogonal and Orthonormal Vectors		
I	Introduction and Fundamentals of Robotics	Automation and its types, definition of Robotics and a Robot, History of Robotics, Advantages and Disadvantages of Robot, Robotic Manipulators, Robot Motions, Robot Anatomy, Links and Joints, Classification of Robots, Specification of Robot, Applications of Robots **Self-learning Topics:** Robot Coordinate System, Economic and Social Aspects of Robotics	**04**	CO1
II	Direct and Inverse Kinematics	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, The Inverse Kinematic Solution of Robots, Case Studies: Three Axes Planar Articulated Robot Arm (Mini-Drafter) and Four Axes Adept-1 SCARA robot **Self-learning Topics:** Study of Five Axes Rhino XR- Robot Arm and Six Axes Articulated Intelledex 660 Robot Arm	**08**	CO2
III	Actuators and Sensors	Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Devices, Pneumatic Devices, Electric Motors, Magnetostrictive Actuators, Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Sniff Sensors, Vision Systems, Voice Synthesizer **Self-learning Topics:** Microprocessor Control of Electric Motors, Microswitches, Range Finders, Voice Recognition Devices	**06**	CO3
IV	Motions, velocities and dynamic analysis of force	Differential relationship, Jacobian, Differential motions of a frame and robot, Inverse Jacobian, Lagrangian mechanics, Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames **Self-learning Topics:** Static Force Analysis of Robots	**08**	CO4
V	Trajectory and Motion Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories, Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug **Self-learning Topics:** Case Study based on real life application of motion planning (eg. Chess Game, Robotic Race, etc.)	**05**	CO5
VI	Introduction to Robot Programming	Definition of Robot Program, Robot Programming Techniques like Online programming, Lead-through programming, Walk-through programming, Offline programming, Task programming, Motion Programming, Robotic Programming Language: Overview, Requirements for Standard Robot Language, Introduction to Robot Languages like AL, AML,	**06**	CO6

		RAIL, RPL, VAL, etc. **Self-learning Topics:** Example of Robot Program using VAL.		

Text Books:

1. Robert Shilling, “Fundamentals of Robotics-Analysis and control”, PHI, 2003.
2. Saeed B. Niku, “Introduction to Robotics Analysis, Systems, Applications”,3rd Edition, Wiley, 2019.
3. Saha, S.K., “Introduction to Robotics”, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
4. Ashitava Ghoshal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press, Sixth impression, 2010
5. Mukherjee S., “Robotics Process Automation”, 1st Edition, Khanna Publishing House, New Delhi, 2020.

References Books:

1. John J. Craig, “Introduction to Robotics – Mechanics & Control”, 3rd Edition, Pearson Education, India, 2009
2. Mark W. Spong & M. Vidyasagar, “Robot Dynamics & Control”, 2nd Wiley India Pvt. Ltd., 2004
3. Aaron Martinez & Enrique Fernandez, “Learning ROS for Robotics Programming”, 1st Edition, Shroff Publishers, 2013
4. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, “Principles of Robot Motion –Theory, Algorithms and Implementations”, Prentice-Hall of India, 2005
5. Fu, Gonzalez, Lee, “Robotics: Control, Sensing, Vision and Intelligence”, 1st Edition, Mc Graw Hill, India.

Online References:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.udemy.com/course/robotics-course/
3. https://www.coursera.org/courses?query=robotics

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8023	ERP	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8023	ERP	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No.	Course Objectives
1	To learn the basic concepts of ERP.
2	To learn different technologies used in ERP.
3	To learn the concepts of ERP Manufacturing Perspective and ERP Modules.
4	To learn what are the benefits of ERP.
5	To study and understand the ERP life cycle.
6	To learn the different tools used in ERP.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts of ERP.	L1,L2
2	Identify different technologies used in ERP.	L1,L2,L3
3	Understand and apply the concepts of ERP Manufacturing Perspective and ERP Modules.	L1,L2
4	Discuss the benefits of ERP.	L1,L2,L3
5	Understand and implement the ERP life cycle.	L1,L2
6	Apply different tools used in ERP.	L1,L2,L3

Prerequisite: Basics of software**.**

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of software.	**02**	**--**

I	Introduction to ERP	Enterprise – An OverviewIntegrated Management Information, Business Modeling,Integrated Data Model **Self-Learning Topics:** Study of advantages of ERP.	**04**	CO1
II	ERP Technologies	Business ProcessingReengineering(BPR), Data Warehousing, Data Mining, On-lineAnalytical Processing(OLAP),Supply Chain Management (SCM),Customer RelationshipManagement(CRM), MIS - Management Information System,DSS - Decision Support System,EIS - Executive InformationSystem **Self-Learning Topics:** Study different ERP technologies.	**06**	CO2
III	ERP Manufacturing Perspective and ERP Modules	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP – Distributed Requirement Planning, PDM - Product Data Management. Finance, Plant Maintenance, Quality Management, Materials Management. **Self-Learning Topics:** Study different ERP modules.	**08**	CO3
IV	Benefits of ERP	Reduction of Lead-Time, On-timeShipment, Reduction in CycleTime, Improved Resource Utilization, Better CustomerSatisfaction, Improved SupplierPerformance, Increased Flexibility,Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability. **Self-Learning Topics:** Study of benefits of ERP for real time application.	**08**	CO4
V	ERP Life cycle	Pre-evaluation Screening, PackageEvaluation, Project Planning Phase,Gap Analysis, Reengineering,Configuration, Implementation Team Training, Testing, GoingLive, End-user Training, Post-implementation (Maintenance mode). **Self-Learning Topics:** ERP testing tools.	**05**	CO5
VI	E-Commerce to E-business	E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real world, ERP Implementation. **Self-Learning Topics:** ERP Applications.	**06**	CO6

Text Books:

1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill.
2. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.
3. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.

References Books:

1. Guide to Planning ERP Application, Annetta Clewwto and Dane Franklin, McGRaw-Hill,1997
2. The SAP R/3 Handbook, Jose Antonio, McGraw – Hill
3. E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A PracticalRoadmap For Success By Dr. Ravi Kalakota

Online References:

1. https://www.udemy.com/
2. https://www.sap.com/
3. www.oracle.com

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8024	Cloud Computing and Services	03	--	--	03	--	--	03

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
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<tr><th>Test1</th><th>Test 2</th><th>Avg. of 2 Tests</th></tr>
<tr><td>ITDO8024</td><td>Cloud Computing and Services</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Objectives:

Sr.No	Course Objectives
1	Understand and analyze the basics of cloud computing, service models, deployment models and architecture.
2	Define and understand the concept of virtualization and related technologies.
3	Understand the different cloud computing services and their relevance's.
4	Describe the various services provided by Amazon Web Services cloud platform.
5	Understand and analyze the functionality of Openstack cloud platform & Severless computing.
6	Describe the aspects of Security & Privacy in cloud computing.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the basics concepts of cloud computing like service models, deployment models and its architecture.	L1,L2,L3
2	Describe and apply virtualization in cloud computing.	L1,L2,L3
3	Use and Analyze different cloud computing services.	L1,L2,L3,L4
4	Understand and apply various services provided by Amazon Web Services cloud platform.	L1,L2,L3
5	Discuss the functionality of Openstack cloud platform & Severless computing.	L1,L2,L3
6	Recognize and examine the security and privacy concerns in cloud computing.	L1,L2,L3

Prerequisite: Computer Network, Operating System.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Computer Network, Network Security and Operating System.	**02**	
I	Introduction to cloud computing	Introduction to cloud computing, need for cloud computing and its components, cloud & other similar configurations, cloud types: NIST and Cloud Cube Model, characteristics of cloud computing, deployment models, service models, advantages and disadvantages of Cloud Computing. **Self-learning Topics:** Study the recent trends in cloud computing architectures and related technologies.	**06**	**CO 1**
II	Virtualization	Characteristics of virtualized environment, structures of virtualization, implementation levels of virtualization, mechanisms of virtualization, pros and cons of virtualization, virtualization vs cloud computing, Xen and KVM architecture. **Self-learning Topics:** Comparison between different virtualization platforms.	**06**	**CO 2**
III	Cloud Computing Services	SPI Model of Cloud computing, Everything as a Service (XaaS): Database as a Service, Storage as a Service, Security as a Service, Collaboration as a Service, Monitoring as a Service, Network as a Service, Disaster Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service. **Self-learning Topics:** Study of different cloud computing platforms providing XaaS services.	**04**	**CO 3**
IV	Amazon Web Service Cloud Platform	Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non relational Databases, Introduction to DynamoDB, Features, Partition and Hash	**09**	**CO 4**

		Keys. **Self-learning Topics:** Comparison of AWS services with other cloud service platforms like Azure and GCP.		
V	Openstack Cloud platform & Severless Computing	Open source Cloud Platform: Introduction to Openstack cloud platform, Components and modes of Operations, Architecture of Openstack cloud platform. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing. Serverless Computing: Introduction, Working with Serverless environment,Basics of severless events and functions, AWS Lambda. **Self-learning Topics:** To study different open source cloud computing platforms and compare them based on different XaaS services provided by them.	**05**	**CO 5**
VI	Cloud Security & Privacy	What is security, why is it required in cloud computing, Different types of security in cloud, attacks, and vulnerabilities,IaaS security, PaaS security, SaaS security, trust boundary, Audit and reporting. Introduction to Identity and access Management (IAM), IAM Challenges, IAM Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services. Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud?, Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC). **Self-learning Topics:** To assess and analyze how the security and privacy is maintained in different cloud computing platforms.	**07**	**CO 6**

Text Books:

1. Cloud computing Bible, Barrie Sosinsky, Wiley publication.
2. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, Dreamtech Press
3. Mastering Cloud Computing, Rajkumar Buyya, MGH publication
4. AWS certified solution Architect, Joe Baron et.al, Cybex publication
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Publication.
6. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication.

Reference Books:

1. Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, Jack Dongarra, Morgan Kaufmann Publication
2. Cloud Computing for Dummies, Judith Hurwitz, Wiley Publication
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication.
4. Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Online References:

1. https://www.aws.amazon.com
2. https://www.nttel.ac.in

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Credits
ILO8011	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation throughclosure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based onit.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of theproject.
5. Capture lessons learned during project phases and document them for futurereference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PMknowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to ProjectManagement Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6

05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting,	8

	engaging with all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and ControllingProjects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **ProjectContracting** Project procurement management, contracting and outsourcing,	
06	**Project Leadership andEthics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **Closing theProject:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed,Project Management Institute PA,USA
3. Gido Clements, Project Management, CengageLearning.
4. Gopalan, Project Management, , WileyIndia
5. Dennis Lock, Project Management, Gower Publishing England, 9 thEd.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total sixquestion
2. All question carry equalmarks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8012	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments andmarket
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividendpolicy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporatefinance
2. Take investment, finance as well as dividenddecisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	10

	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, andModigliani-Miller Approach	03

REFERENCES:

1. FundamentalsofFinancialManagement,13th Edition(2015)byEugeneF.BrighamandJoelF. Houston; Publisher: Cengage Publications, NewDelhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, NewDelhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, NewDelhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, NewDelhi.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total sixquestion
2. All question carry equalmarks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8013	**Enterprepreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management ofbusiness
2. Understand Indian environment forentrepreneurship
3. Idea of EDP,MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan andownerships
2. Interpret key regulations and legal aspects of entrepreneurship inIndia
3. Understand government policies forentrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to theEntrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development forSMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises,e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHillCompany
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, NewDelhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, NewDelhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya PublishingHouse
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIMAhmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann PublicationLtd.
9. Kurakto, Entrepreneurship- Principles and Practices, ThomsonPublication
10. Laghu UdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total sixquestion
2. All question carry equalmarks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8014	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today'sorganizations.
3. To familiarize the students about the latest developments, trends & different aspects ofHRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders andmanagers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resourcemanagement.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizationalperspective.
3. Gain knowledge about the latest developments and trends inHRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers andmanagers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRMfunctions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring andrightsizing, Empowerment, TQM, Managing ethicalissues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing SelfAwareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude andBehavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg,McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directedteam. • Casestudy	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflictsand	6

	stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics atworkplace, Tactics andstrategies.	
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employeemorale. • Performance Appraisal Systems: Traditional & modernmethods, Performance Counseling, CareerPlanning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture,Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity,managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and serviceindustries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed,2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excelpublishing
3. Aswathapa, Human resource management: Text & cases, 6th edition,2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition,2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5thEd, 2013, HimalayaPublishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

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4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8015	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics inbusiness
2. To recognized corporate socialresponsibility

Outcomes: Learner will be able to…

1. Understand rights and duties ofbusiness
2. Distinguish different aspects of corporate socialresponsibility
3. Demonstrate professionalethics
4. Understand legal aspects of corporate socialresponsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher:Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher:Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, NewDelhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, NewDelhi.

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End Semester Theory Examination:

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4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8016	**Research Methodology**	**03**

Objectives:

1. To understand Research and ResearchProcess
2. To acquaint students with identifying problems for research and develop researchstrategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matterareas
2. Accurately collect, analyze and reportdata
3. Present complex data or situationsclearly
4. Review and analyze researchfindings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vsMethodology Need of Research in Business and SocialSciences Objectives ofResearch **Issues** and Problems inResearch Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** Basic Research AppliedResearch Descriptive Research Analytical Research EmpiricalResearch **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** Research Design – Meaning, Types andSignificance Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques SamplingErrors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of ResearchProblem **b.** Formulation of ResearchProblem **c.** Review ofLiterature **d.** Formulation ofHypothesis **e.** Formulation of researchDesign **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation ofData	**08**

	j. Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** Preparation of the report on conclusionreached Validity Testing & EthicalIssues Suggestions andRecommendation	**04**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley EasternLimited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Assessment:

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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total sixquestion
2. All question carry equalmarks
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4. Only Four question need to besolved.

Course Code	Course Name	Credits
ILO8017	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protectionsystem
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure andapplications

Outcomes: Learner will be able to…

1. understand Intellectual Propertyassets
2. assist individuals and organizations in capacitybuilding
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property andPatenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technologyetc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frameand cost, Patent Licensing, Patent Infringement	07

	Patent databases: Important websites, Searching international databases	

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants ofIndia
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on PatentLaws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer LawInternational
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge UniversityPress
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet &Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition,TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual PropertyRights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific PublishingCompany
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India PublishingAgency
14. Vivien Irish, 2005, Intellectual Property Rights forEngineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

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End Semester Theory Examination:
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Course Code	Course Name	Credits
ILO8018	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint withE-commerce
3. To give insights into E-business and itsstrategies

Outcomes: The learner will be able to …..

1. Identify drivers of digitalbusiness
2. Illustrate various approaches and techniques for E-business andmanagement
3. Prepare E-business plan

Module	**Detailed content**	**Hours**
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e- commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts ofEC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection ofstrategy, E-business strategy into Action, challenges and E-Transition (Process of DigitalTransformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors,2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted,2002
3. Digital Business and E-Commerce Management, 6thEd, Dave Chaffey, Pearson, August2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER,2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2ndEdition,Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito,Springer
7. Digital Business Discourse Erika Darics, April 2015, PalgraveMacmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of ElectronicGovernance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Assessment:

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Course Code	Course Name	Credits
ILO8019	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts ofecology
3. Familiarise environment relatedlegislations

Outcomes: Learner will be able to…

1. Understand the concept of environmentalmanagement
2. Understand ecosystem and interdependence, food chainetc.
3. Understand and interpret environment relatedlegislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain,etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London,1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Ockwell, Edward ElgarPublishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERIPress**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India,2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. AccessPublishing.2015

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University of Mumbai

No. AAMS(UG)/ 130 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/167 of 2017-18 dated 8th August, 2017, relating to the revised syllabus as per (CBCS) for Bachelor of Engineering (Mechanical Engineering) (Sem. III & VIII) be revised for S.E. (Sem. III & IV) from Academic Year 2017-18, Third Year (Sem. V & VI) from Academic Year 2018-19 and Bachelor of Engineering (Sem. VII & VIII) from Academic Year 2019-20.

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31st May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.45 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.45 (R) and that in accordance therewith, the revised syllabus of **B.E. (Mechanical Engineering) (Sem.- VII & VIII) (CBCS)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.45 (R)/11/07/2022

****

No. AAMS(UG)/ 130 -A of 2022-23 20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Mechanical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11 July, 2022
Item No. – 6.45 (R)

University of Mumbai

Revised Syllabus for
B.E. (Mechanical Engineering)
Semester – (VII & VIII)
(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: ____________ **Title of Course**	B.E. (Mechanical Engineering)
O: ____________ **Eligibility**	After Passing Third Year Engineering as per the Ordinance 0.6243
R: ____________ **Passing Marks**	40%
No. of years/Semesters:	8 semesters
Level:	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised 2019 'C' Scheme
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Signature:

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in
Mechanical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

Signature:

AMajumdar

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' Scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the Institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

When the entire world is discussing about ‘Industry 4.0’, we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders.We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member
Dr. V. B. Tungikar : Member
Dr. K.P. Karunakaran : Member
Dr. S. S. Thipse : Member
Dr. Milind Deshmukh : Member

Program Structure for Final Year Engineering

Semester VII & VIII

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
MEC701	Design of Mechanical System	4	--	4	--	4
MEC702	Logistics and Supply Chain Management	3	--	3		3
MEDLO703X	Department Level Optional Course – 3	3	--	3	--	3
MEDLO704X	Department Level Optional Course – 4	3	--	3	--	3
ILO701X	Institute Level Optional Course – I*	3	--	3	--	3
MEL701	Design of Mechanical System	--	2	--	1	1
MEL702	Maintenance Engineering	--	2	--	1	1
MEL703	Industrial Skills	--	2	--	1	1
MEP701	Major Project I	--	$6^{\#}$	--	3	3
Total		**16**	**12**	**16**	**6**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC701	Design of Mechanical System	20	20	20	80	3	--	--	100
MEC702	Logistics and Supply Chain Management	20	20	20	80	3	--	--	100
MEDLO703X	Department Level Optional Course – 3	20	20	20	80	3	--	--	100
MEDLO704X	Department Level Optional Course – 4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course – I*	20	20	20	80	3	--	--	100
MEL701	Design of Mechanical System	--	--	--	--	--	25	25	50
MEL702	Maintenance Engineering	--	--	--	--	--	25	25	50
MEL703	Industrial Skills	--	--	--	--	--	25	25	50
MEP701	Major Project I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	--	**125**	**75**	**700**

# indicates work load of Learner (Not Faculty), for Major Project

* Common with all branches

Semester VIII

Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Pract./Tut.**	**Theory**	**Pract.**	**Total**
MEC801	Operations Planning and Control	3	--	3	--	3
MEDLO805X	Department Level Optional Course – 5	3	--	3	--	3
MEDLO806X	Department Level Optional Course – 6	3	--	3	--	3
ILO802X	Institute Level Optional Course – 2*	3	--	3	--	3
MEL801	Product Design and Development	--	2	--	1	1
MEL802	Laboratory based on IoT	--	2	--	1	1
MEP801	Major Project II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	**Course Name**	**Examination Scheme**							
		Theory					**Term Work**	**Prac./Oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (Hrs)**			
		Test1	**Test2**	**Avg**					
MEC801	Operations Planning and Control	20	20	20	80	3	--	--	100
MEDLO805X	Department Level Optional Course – 5	20	20	20	80	3	--	--	100
MEDLO806X	Department Level Optional Course – 6	20	20	20	80	3	--	--	100
ILO802X	Institute Level Optional Course – 2*	20	20	20	80	3	--	--	100
MEL801	Product Design and Development	--	--	--	--	--	25	25	50
MEL802	Laboratory based on IoT	--	--	--	--	--	25	25	50
MEP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

* Common with all branches

Students group and load of faculty per week.

Major Project 1 and 2:

Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: In Semester VII – ½ hour per week per project group

In Semester VIII – 1 hour per week per project group

Department Optional Courses

Course Code	Sem. VII: Department Optional Course- 3		Course Code	Sem. VII: Department OptionalCourse - 4
MEDLO7031	Automotive Power Systems		MEDLO7041	Machinery Diagnostics
MEDLO7032	Renewable Energy Systems		MEDLO7042	Vibration Controls
MEDLO7033	Vehicle Systems		MEDLO7043	Advanced Vibration

Course Code	Sem. VIII: Department Optional Course- 5		Course Code	Sem. VIII: Department OptionalCourse - 6
MEDLO8051	Composite Materials		MEDLO8061	Product Design and Development
MEDLO8052	Smart Materials		MEDLO8062	Design for X
MEDLO8053	Micro Electro Mechanical Systems		MEDLO8063	Total Quality Management

Institute Optional Courses

Course Code	Institute Optional Course-I #		Course Code	Institute Elective Course-II #
ILO7011	Product Lifecycle Management		ILO8021	Project Management
ILO7012	Reliability Engineering		ILO8022	Finance Management
ILO7013	Management Information System		ILO8023	Entrepreneurship Development and Management
ILO7014	Design of Experiments		ILO8024	Human Resource Management
ILO7015	Operation Research		ILO8025	Professional Ethics and CSR
ILO7016	Cyber Security and Laws		ILO8026	Research Methodology
ILO7017	Disaster Management and Mitigation Measures		ILO8027	IPR and Patenting
ILO7018	Energy Audit and Management		ILO8028	Digital Business Management
ILO7019	Development Engineering		ILO8029	Environmental Management

# Common with all branches

Course Code	Course Name	Credits
MEC701	**Design of Mechanical System**	**04**

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. 2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Select appropriate gears for power transmission on the basis of given load and speed
3. Design material handling systems such as hoisting mechanism of EOT crane,
4. Design belt conveyor systems
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design pumps for the given applications

Module	Contents	Hours
1.	Methodology & Morphology of design, Optimum design, system concepts in design.	**04**
2.	**Design of Transmission Gear Box:**	**12**
	Single stage andTwo stage Gear box with fixed ratio consisting of Design of spur, helical, bevel and worm and wormwheel gear pairs, Gear box housing layout and housing design.	
3.	**Design of Hoisting Mechanism:**	**10**
	Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	
4.	**Design of Belt Conveyors :**	
	Power requirement, selection of belt, design of tension take up unit, idler pulley	**04**
5.	**Engine Design (Petrol and Diesel):**	
	Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	**10**
6.	**Design of Pump:**	**08**
	5.1 Design of main components of gear pump.	
	1 Motor selection	
	2 Gear design	
	3 Shaft design and bearing selection	
	4 Casing and bolt design	
	5 Sizing of design of suction and delivery pipe	
	5.2 Design of main components of Centrifugal Pump:	
	1 Motor selection	

	2 Suction and Delivery pipe	
	3 Design of Impeller, Impeller shaft	
	4 Design of Volute Casing	

Sr. no.	Text/Reference Books: -
1	“Machine Design Exercises”, S.N.Trikha - New Delhi Khanna Publisher 1978.
2	“Mechanical Engineering Design”, Shigley J E and Mischke C R,11th Edition 2019, McGraw Hill, ISBN: 9788184956207.
3	“Mechanical design analysis”, MF Spotts, 3rd Edition, Prentice Hall Inc.
4	“Design of Machine Elements”, Bhandari VB,5th Edition 2020, TMH,ISBN: 9789390177479
5	“Machine Design”, Black PH and O Eugene Adams, 3rd Edition, McGraw Hill ISBN 10: 0070055246
6	“Design Data”, P.S.G. College of Technology, Coimbatore. ISBN: 978-8192735504
7	“Engineering Design”, Dieter G E, McGraw Hill Inc, ISBN: 9781260113297
8	“Mechanical System Design”, SP Patil, 2nd Edition., JAICO Publishing House ISBN: 978-8179923153
9	“Material Handling Equipment”, Rudenko,2nd Edition, M.I.R. publishers, Moscow
10	“Machine Design-An Integrated Approach”, Robert L. Norton,6th Edition, Pearson Education, ISBN: 9780135184233
11	“Material Handling Equipments”, N. Rudenko, Peace Publication
12	“Material Handling Equipments”, Alexandrov,5th Edition, Mir Publication ISBN: 9780714717456
13	Machine Desgin”, Reshetov, Mir Publication 1978.
14	“Machine Design”, R.C.Patel, Pandya, Sikh, Vol -I & II,12th Edition, C. Jamnadas& Co.
15	“Design of Machine Elements”, 4th Edition, V. M. Faires, ISBN: 978-0023359507
16	“Pumps: Theory, Design and Applications”, G K Sahu, New Age International 2000 ISBN: 9788122412246

17 “Gear Design Handbook”, GitinMaitra, 2nd Edition, ISBN: 978-0074602379

18 “Design Data Book- Design of engine parts”,Khandare S.S & Kale A.V, 2nd Edition, ISBN: 978-9352654260

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_me62 - Gear And Gear Unit Design: Theory and Practice, IIT Kharagpur
2. https://nptel.ac.in/courses/112/106/112106137/ - Machine Design-II, IIT Madras

Course Code	Course Name	Credits
MEC702	**Logistics and Supply Chain Management**	**03**

Objectives:

1. To understand the fundamentals of supply chain management and Logistics
2. To develop an understanding related to Supply Chain Performance and related aspects
3. To understand Inventory management in supply chain
4. To learn tools and techniques used in logistics, transportation, warehousing and outsourcing decisions.
5. To develop critical understanding towards digitization in supply chain management and sustainability
6. To develop analytical and critical understanding for planning and designing supply chain network.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Demonstrate a sound understanding of Logistics and Supply Chain Management concepts and their role in today's business environment.
2. Identify the drivers of supply chain performance and risks in supply chain management.
3. Apply various techniques of inventory management and rank the items using inventory management technique
4. Apply various strategies and techniques to minimize overall logistics cost
5. Understand the role of digitization in supply chain management leading to sustainability
6. Apply various mathematical models/tools to design the supply chain network

Module	Contents	Hours
1.	**Introduction:** Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers /decisions and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM. Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing	**05**
2.	**Supply Chain Performance:** Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network. Supply Chain Risk Management **(**Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security. Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.	**09**

3.	**Inventory management:** Definition of Inventory, Inventory types & functions; EOQ Model and Buffer Stock, Assumptions, Instantaneous Replenishment case, Demand and production rate are different, when backorders are allowed, Buffer Stock and ROL. Replenishment systems (Q and P system) Inventory Control- ABC Analysis, Numerical problems on ABC analysis,VED Analysis	**06**
4.	**Logistics Management and outsourcing:** Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation- Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking. Warehousing: Concept and types, Warehousing strategy, Warehouse facility location & network design Part Packaging, Use of Returnable pallets, ASN – Advance Shipment Notification. Reverse logistics: Outsourcing - Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL), Cold chain operations in Supply chain.	**08**
5.	**Digitization in supply chain Management and Sustainability:** IT in supply chain - Role of IT in a supply chain, The supply chain IT framework, Application of Bar coding, Significance of SAP/RFID, The future of IT in the supply chain, Supply chain IT in practice, TMS (Transport Management System), WMS (Warehouse Management System) Green supply chain management, Supply Chain sustainability, Supply Chain sustainability index measurement with case studies. Social aspects of supply chain (CSR), Environment aspects of supply chain (CO2 emission), resource utilization, recycling.	**04**
6.	**Supply Chain Network Design:** Factors influencing distribution network design, Supply chain resilience, Design options for distribution network, Introduction to mathematical modelling, considerations in modelling SCM systems, Overview of the models, Models on transportation, Transportation problem, Vehicle routing problem, Travelling salesman problem, Capacitated transhipment problem, shortest path problem. Value Stream Mapping (VSM), Order Fulfillment Process Flow, understanding the terms related to Supply chain- Lead Time, Takt Time ,Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)	**07**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books: -

1. R.P. Mohanty, S.G. Deshmukh, "Essentials of Supply Chain management", 1st Edition 2004, Jaico Publishing House.
2. S.K. Bhattacharya, "Logistics Management", 3rd Edition, Pearson Publication ISBN: 9788131768624
3. Sunil Chopra, P. Meindl, "Supply Chain Management", 6th Edition 2016, Pearson Education Asia.
4. Martin Christopher, "Logistics and Supply Chain Management",4th Edition 2010, Pitman Publishing.
5. Bowon Kim, "Supply Chain Management in Mastering Business in Asia", Edition 2005, John Wiley & sons (Asia) Pvt Ltd, ISBN: 978-0470821404
6. Michael Hugos, "Essentials of Supply Chain Management", 4th Edition 2018, John Wiley and Sons, ISBN: 9781119461104
7. Rahul V Altekar, "Supply Chain Management: Concepts and cases", Edition 2009, PHI, ISBN: 9788120328594.
8. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, "Designing and Managing the Supply Chain concepts, Strategies and Case studies", 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_mg74/preview
2. https://onlinecourses.swayam2.ac.in/cec22_mg22/preview

Course Code	Course Name	Credits
MEDLO7031	**Automotive Power Systems**	**03**

Objectives:

1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To provide insight into the harmful effects of engine pollutants and its control
3. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to…

1. Demonstrate the working of Fuel supply and ignition system of I.C. engines
2. Illustrate the working of lubrication, cooling and supercharging systems.
3. Comprehend the different technological advances in engines and alternate fuels
4. Identify and describe the history and different EV/HEV drivetrain topologies
5. Compare and evaluate various energy sources and energy storage components for EV and HEV application.
6. Comprehend EV and HEV working through Case studies.

Module	**Details**	**Hours**
1.	Constructional Features of I.C. Engines. Parts of I.C. engine and their materials. **Fuel Supply System :** Fuel-Air ratio, Fuel air mixture requirement, Conventional fuels used in IC engines, Fuel injection system in SI and CI engine and MPFI Engine. **Ignition System :** Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker.	**08**
2.	**Lubrication System :** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems	**06**

	Cooling System : Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbocharging :** Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers (No Numericals)	
3.	**Engine Exhaust Emission and its control** Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms. **Alternative Fuels** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	**08**
4.	**Introduction to Hybrid and Electric Vehicles:** History of Electric Vehicles (EV) and Hybrid electric vehicles (HEV), need and importance of EV and HEV, Indian and Global Scenario of EV and HEV. **Drivetrain topologies:** Electric traction and hybrid traction system, Electric drive topologies, hybrid drivetrain topologies. **Power energy supply requirement for EV/HEV applications.**	**06**

5.	**Electric Drives and controller:** Electric system components for EV/HEV, AC and DC motor drives, RPM and Torque calculation of motor, Motor Controllers,	**05**
6.	**Energy Sources for EV/HEVs:** Requirement of energy supplies and storage in EV/HEV, Types of batteries(Lead Acid/Li-ion/NiMH) and its working, battery specifications, Battery Management system; Fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, Concept of Hybridisation for different energy sources. **Energy Management Strategies:** EV/HEV energy management strategies, classification and comparison of various energy management strategies **Battery charging:** Type of battery charging systems, Selection and Sizing of charging station, Components of charging station. Single line diagram of charging station, On board Charger. Payback period of EV and HEV **Case Study: Toyota Prius, Honda Insight, Tata Nexon EV**	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text Books:

1. A Course on Internal Combustion Engine,Mathur and Sharma,Dhanpat Rai & Sons,New Delhi,2001.
2. Internal Combustion Engine,V.Ganesan,Mc Graw Hill,1995
3. Internal Combustion Engine, Domkundwar & Domkundwar,Dhanpat Rai & Sons,New Delhi,2013.
4. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, CRC Press,2005

Reference Books:

1. Fundamental of Internal Combustion Engines,Gill and Smith,Oxford & IBH Publishing Company Pvt.ltd,2007
2. Internal Combustion Engine Fundamentals,Heywood,McGraw Hill,1988
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press,2003
4. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley,2003

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/107106088
2. https://nptel.ac.in/courses/112103262
3. https://nptel.ac.in/courses/108102121
4. https://nptel.ac.in/courses/108106170

Course Code	Course Name	Credits
MEDLO7032	**Renewable Energy Sources**	**03**

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study design and installation criteria of various equipment's to convert the renewable energy into useful energy.
3. To study economics of harnessing energy from renewable energy sources.

Outcomes: Learner will be able to…

1. Describe the need for renewable energy and its potential for the development of a sustainable environment.
2. Analyze different solar collectors using geometrical parameters and photovoltaics for generation of solar energy.
3. Identify and analyze various wind turbine energy harnessment techniques.
4. Design biogas plant for harnessing energy from organic waste.
5. Describe significance of hydrogen energy to fulfill present and future energy needs.
6. Describe the operating principle of geothermal energy and ocean energy and their role in sustainable development.

Module	Contents	Hours
1	**1.1: Introduction to Renewable Energy Sources and Solar Radiation**: Global and National current energy scenarios, Prospects of renewable energy sources and renewable energies role in developing sustainable model. **1.2:** Solar radiation terms, solar geometry, earth sun angles, attenuation and measurement of solar radiation on horizontal and inclined surfaces, methods of solar radiation estimation.	**05**
2	**Solar Thermal Energy:** **2.1:** Introduction and working principle of flat plate collectors, thermal performance analysis of flat plate collectors, concentrating collectors, Installation and maintenance criteria of solar thermal systems.	**07**

	2.2: Solar thermal devices- Solar air heater and different types of solar air heaters, solar water heater and different types of solar water heaters, solar dryers, solar pond, solar distillation, solar still, solar cooker. **2.3:** Solar space heating & cooling, solar refrigerator, solar thermal energy storage systems. Case Study: Solar thermal power plant working operation.	
3	**Solar Photovoltaic Energy:** **3.1:** Introduction and working principle of a solar PV systems, types of solar PV cells, solar tracking systems, controls and measurement methods of solar PV systems. **3.2:** Methods to improve the efficiency of PV cells, parameters which affect the efficiency and life cycle of PV cells. Case Study: Installation of 1 kW of solar PV plant.	**07**
4	**Wind Energy**: **4.1:** Basic components and working principle of wind energy conversion systems, wind data and site selection considerations, various types of wind energy conversion systems, constructional features of horizontal and vertical axis wind machines, performance analysis of horizontal and vertical axis wind machines. **4.2:** Estimation of power output- betz limits, Environmental impacts of wind energy.	**06**
5	**5.1: Energy from Biomass**: Introduction of bioenergy, conversion technologies, types of biogas generation plants, design and construction details of biogas plant (KVIC), site selection, digester design consideration, filling a digester for starting, maintaining biogas production, utilization of biogas.	**07**

	5.2: Hydrogen Energy: Introduction and application, General introduction to infrastructure requirement for hydrogen production, storage, dispensing & utilization. Principles of fuel cells, types of fuel cells, power generation by fuel cells, applications of fuel cells.	
6	**6.1: Geothermal Energy**: Introduction to geothermal technologies and methods of extracting geothermal energy, prospects of geothermal energy in India. **6.2: Energy from the ocean**: Wave energy characteristics and wave energy conversion devices, tide energy conversion devices, Ocean Thermal Energy Conversion (OTEC) systems. **6.3: Energy management and economics:** Energy conservation, energy security, energy economics, energy audit- definition, need, types of energy audit, Energy management (audit) approach-understanding energy costs, Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating.	**07**

Visit to wind farm/solar plant/biogas plant.

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**

3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four questions need to be solved.

Reference Books:

1. "Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409-073-7
2. "Renewable Energy: Power for a Sustainable Future", Edited by Godfrey Boyle, 3rd Edition 2012, Oxford University Press, ISBN: 978-0199681273
3. "Solar Energy: Principles of Thermal Collection and Storage", SP Sukhatme and J K Nayak, 4th Edition, Tata Mcgraw Hill Publishing Co. Ltd.
4. "Solar Energy: Fundamentals and Applications", H.P. Garg& Jai Prakash, First Revised Edition, Tata McGraw-Hill Education.
5. "Wind Power Technology", Joshua Earnest, 2nd Edition, PHI Learning, 2015.
6. "Solar Engineering of Thermal Processes", John A . Duffie and William A Bechman, 4th Edition, Wiley Publications.
7. "Renewable Energy Sources", J W Twidell& Anthony D. Weir, 3rd Edition 2015,ELBS Pub, ISBN: : 978-1-315-76641-6
8. "Energy Conversion Systems", Rakosh Das Begamudre, New Age International (P) Ltd., Publishers, New Delhi, 2007, ISBN: 9788122412666
9. "Solar Photovoltaics: Fundamentals, Technologies and Applications", C S Solanki, 3rd Edition, PHI Learning.
10. "Biomass Regenerable Energy", D. D. Hall and R. P. Overend, John Wiley, New York, ISBN:047190919X
11. "Wind and Solar Power Systems", Mukund R Patel, 2nd Revised Edition, CRC Press, ISBN: 9780429114960
12. "Wind Energy Explained: Theory, Design and Application", J F Manwell, J.C. McGowan, A.L.Rogers,2nd Edition 2009, John Wiley and Sons.

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/103107157
3. https://nptel.ac.in/courses/115105127

Course Code	Course Name	Credits
MEDLO7033	**Vehicle Systems**	**03**

Objectives:

1. To study basic and advanced vehicle systems
2. To study basic and advanced vehicle electrical systems
3. To study different chassis structures components.
4. To familiarize with the latest technological developments in automotive technology

Outcomes: Learner will be able to

1. Understand the working of different Vehicle Systems and Subsystems.
2. Understand the working of different Vehicle Electrical systems and subsystems.
3. Understand different Vehicle Body systems and layouts.
4. Illustrate working, functions of different vehicle mechanical, electrical, and chassis systems.
5. Understand the effect of aerodynamics on the functioning of a vehicle.
6. Comprehend the different technological advances in vehicle systems.

Module	Details	**Hours**
1.	**Power Flow Layout:** FE FWD,FE RWD,RE FWD,RE RWD, Underfloor Engine **Clutches:** Necessity of clutch in a automobile, Working and Construction of Single plate, Multi plate, Centrifugal, Semi Centrifugal, electromagnetic clutches, Fluid Flywheel **Transmission**: Purpose and Elements of Gear Box, Characteristic Curves, Types- Sliding mesh, Constant Mesh, Synchromesh, Planetary Gear set, Torque Converter, Semi-Automatic and Automatic **Drive Line**:	**08**

	UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line,2WD,4WD,Part time and Full time 2WD and 4WD.	
2.	**Final Drive** Types of Final drive; spiral, bevel, Hypoid and worm drives. **Differential** Necessity of differential, Working of differential, Conventional and non-slip differential. **Axles** : Types of live axles; semi, three quarter and full floating axles. Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine **Steering**: Requirement, Types of Steering Gear Box, Steering Geometry, Wheel Alignment and Wheel balancing, Power Steering **Brakes**: Principle, Types; Hydraulic, Air, Electric, Exhaust, Regeneration ,Brake lining materials, ABS, EBD	**08**
3.	**Suspension**: Requirement and Types-Independent, Dependent, Air. Types of Shock absorbers ,Leaf spring types **Wheels and Tyres**: Tyre requirement, tire characteristics, Constructional detail, , tyre dimensions and specifications, Types of wheels and Hubs	**06**
4.	**AUTOMOTIVE ELECTRICAL SYSTEMS** **Batteries**: Construction, Types: Lead Acid, Alkaline,Nickel Metal Hydride, Lithium Ion, Battery Ratings, Battery Charging **Starting:**	**08**

	Requirement, Starter Motor Drives, cold cranking Amperes **Charging:** Requirement, Principle and Construction of Dynamo and Alternator **Ignition:** Mechanical and Electronic Ignition and Electronic Engine Control **Lighting and Wiring:** Types of Lamps, Gauges, Cable Sizes, Color Codes, Multiplex Wiring systems **Accessories:** Electric Horn, Wipers, Fuel Pumps, Power operated windows, Fuel Gauges, OBD systems	
5.	**Body Engineering:** Chassis types and Structure types-Open, Semi Integral and Integral, Loads acting on chassis, Basic Dimensions and Visibility **Vehicle Aerodynamics :** Aerodynamic drag: Aerodynamic lift and Pitching moments, Side force, Yawing & Rolling moments.	**06**
6.	**Recent Technological Developments in Automobile:** Telematics, Intelligent Vehicles systems,V2V and V2I communication. Scope of AI in Automobile Vehicle	**03**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. J Powloski, "Vehicle Body Engineering", Business Books Ltd., London
3. Automobile Mechanics, N. K. Giri, 8thEdition, Khanna Publishers
4. P. L. Kohli, "Automotive Chassis & Body", Papyrus Publishing House, New Delhi.
5. Tom Denton,Automobile Electrical and Electronics System,Elsevier Third Edition,2003

Reference Books :

1. John Fenton, "Vehicle Body Layout & Analysis", Hutchinson, London.
2. Bosch Automotive HandBook, 6thEdition, SAE Publications
3. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/107106088
2. https://nptel.ac.in/courses/107103084
3. https://nptel.ac.in/courses/113106082

Course Code	Course Name	Credits
MEDLO7041	**Machinery Diagnostics**	**03**

Objectives :

1. To study basic concepts of Vibration Monitoring.
2. To study different Vibration Measuring Instruments.
3. To study fault detection in Machines using vibration spectrum.

Outcomes: Learner will be able to…

1. Relate basic concepts of Machinery Diagnostic.
2. Describe the working of Vibration Measuring Instruments.
3. Apply different Signal Processing Techniques in Vibration Measurement.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Module	Contents	Hours
1	**1.1 Basics of Vibration** Periodic and random motion, Spectral Amplitude Scaling: RMS, Peak and Peak-to-Peak Conversion and Selection, Time and frequency domain analysis, Phase analysis, Orbit analysis, Understanding signal pattern, Importance of speed in accurate diagnosis, Importance of side bands in frequency spectrums. **1.2 Introduction to Vibration based Condition Monitoring** Maintenance Principles, Vibration based fault Prognosis, Goal of Vibration Monitoring, Steps in Vibration Monitoring, Benefits of Vibration based condition monitoring.	**07**
2	**Vibration Measurement** Vibration measuring instruments: displacement, velocity, acceleration; Force measurement, Laser based measurements: laser vibrometer Sensor Selection Criteria , Sensor – Mounting Locations and Techniques	**07**
3	**Data Acquisition & Signal Processing** Classification of signals, Signal analysis, Fast Fourier Transform (FFT), Essential Settings in Data Acquisition System (Plot Formats, Frequency Span and Frequency Resolution, Average Types and Number of Averages, Windowing, Spectrum Scaling), Signal conditioning	**07**
4	**Machinery Fault Diagnosis I** Natural frequency and resonance tests (Practical approach), Time and Frequency domain analysis to identify unbalance, bent shaft, Misalignment, Soft foot conditions, Mechanical looseness	**06**

5	**Machinery Fault Diagnosis II** Rolling element bearing and Journal Bearing fault diagnosis, Faults related to Gearbox, vane defects in pumps, Fault in Fans and Blowers.	**06**
6	**Applications of Condition Monitoring** Case studies related Balancing Problems in Turbines, Condition Monitoring in Sugar mills, Health Monitoring of Journal Bearing, Condition Monitoring of Industrial Pumps. (Aspects to be covered : Selection of sensors, recommended location of sensor, direction of measurement, selection of plot type, Data validation and Identification of Faults)	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. R.B. Randall, “Vibration-based Condition Monitoring”, Wiley2021, ISBN: 978-1-119-47755-6
2. A.R. Mohanty, “Machine Condition Monitoring: Principles and Practices”, CRC Press 2017, ISBN: 9781138748255
3. R.A. Collacott, “Mechanical Fault Diagnosis and Condition Monitoring”,1st Edition, Chapman and Hall, ISBN: 978-94-009-5723-7
4. J.S. Rao, “Vibratory Condition Monitoring of Machine”, Narosa Publishing House.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112105232 – Machinery Fault Diagnosis and Signal Processing, IIT, Kharagpur

Course Code	Course Name	Credits
MEDLO7042	**Vibration Controls**	**03**

Objectives :

1. To study Vibration Absorbers.
2. To study Vibration Isolators.
3. To study Vibration Control.

Outcomes: Learner will be able to…

1. Apply basic concepts of Vibration Isolation and Damping.
2. Identify suitable Vibration Absorber
3. Identify suitable Vibration Isolator
4. Apply suitable method to Control the vibrations to the acceptable level.

Module	Contents	Hours
1	**1.1 Introduction:** Vibration reduction at source, factors affecting vibration level, isolation of the source, methods of vibration control, dynamic properties and selection of materials	**05**
2	**2.1 Dynamic vibration absorbers:** Dynamic vibration neutralizers, self-tuned pendulum neutralizer, optimum design of damped absorbers, absorber with ideal spring and viscous dashpot, gyroscopic vibration absorbers, impact absorbers, absorbers attached to continuous systems	**08**
3	**3.1 Vibration isolation of single degree of freedom systems:** Isolators with complex stiffness, Isolators with Coulomb damping, Three-element isolators, Two-stage isolators, Pneumatic suspension, Concept of negative stiffness in vibration isolation	**08**
4.	**4.1 Active vibration control:** Classification and modelling, actuators and sensors for active vibration control, Active vibration absorption and damping, classical control, optimal control, Piezoelectric transducers for active vibration control **4.2 Semi-active vibration control:** Introduction, Magneto-rheological fluids, MR models and devices, semi-active suspension, narrowband disturbance	**08**

5	**5.1 Active, semi-active, and adaptive dynamic vibration absorbers:** Active tuned vibration absorber, active mass damper, adaptive vibration absorber, semi-active tuned vibration absorber	**05**
6	**6.1 Active and semi-active vibration isolation:** Active single-axis base isolation, active force isolation system, isolator based on piezoelectric stack actuator, semi-active isolation, Adaptive-passive vibration isolation, active control of vehicle suspensions	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

5. Question paper will comprise of total **six questions, each carrying 20 marks.**
6. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
7. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only **Four questions need to be solved**.

Text/Reference Books:

1. A.K. Mallik and A. Chatterjee, “Principles of Active and Passive Vibration Control”, East-West-Press 2014, ISBN: 9788176710985
2. A. Preumont, “Vibration Control of Active Structures”, Springer 2018, ISBN: 9783319722962
3. S.S. Rao, “Mechanical Vibrations”, 5th Edition 2004, Pearson Publications
4. Clarence de Silva, “Vibration: Fundamentals and Practice”,1st Edition 2000, CRC Press, ISBN: 0849318084

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112104211– Principles of Vibration Control, IIT Kanpur

https://nptel.ac.in/courses/112107088– Vibration control, IIT Roorkee

Course Code	Course Name	Credits
MEDLO7043	**Advanced Vibration**	**03**

Objectives :

1. To study the Multi-degree of freedom system.
2. To study different vibration measurement and control methods, and required instruments.
3. To study basic concepts of Random Vibrations.
4. To study the basic concepts of nonlinear vibrations.

Outcomes: Learner will be able to…

1. Estimate natural frequency of mechanical element / system.
2. Understand the concepts of Vibration Isolation and Control.
3. Analyse vibratory response of mechanical element / system.
4. Analyse vibration of Continuous system.
5. Analyse Random Vibrations.
6. Analyse Non-Linear Vibrations.

Module	Contents	Hours
1	**Multi Degree of Freedom System:** **1.1 Undamped free vibration:** Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems **1.2 Eigen Values and Eigen vectors:** for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	**06**
2	**2.1 Vibration Isolation and Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers, Passive, semi-active, and active vibration control	**06**
3	**3.1 Vibration Measurement:** Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **3.2 Modal analysis and Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine condition monitoring and diagnosis.	**06**
4	**Vibration of Continuous Systems:** Vibration of string, Longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	**07**
5	**Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.	**07**
6	**Non-Linear Vibrations:** Introduction, Sources of nonlinearity, Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations, Runge-Kutta method.	**07**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. W.T. Thomson and M.D. Dahleh, “Theory of Vibration with Applications”, 3rd Edition 2002, Pearson Education
2. G.K. Grover, “Mechanical Vibraitons”, 5th Edition 2009, Nem Chand and Bros, ISBN: **978-8185240565**
3. W.W. Seto, “Mechanical Vibrations- Schaum's Outline Series”, McGraw Hill, ISBN: 9780070563278
4. S.S. Rao, “Mechanical Vibrations”, 5th Edition 2004, Pearson Publications
5. Leonard Meirovitch, “Fundamentals of Vibration”, 1st Edition 2010, McGraw Hill, ISBN: 978-1577666912.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112107212 – Introduction to Mechanical Vibration, IIT Roorkee
https://nptel.ac.in/courses/112103111 – Mechanical Vibrations, IIT Guwahati
https://nptel.ac.in/courses/112103022 – Nonlinear Vibration, IIT Guwahati
https://nptel.ac.in/courses/112104211 – Principles of Vibration Control, IIT Kanpur

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant
5.

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	**05**
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No.	Detailed Contents	Hrs
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**08**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**08**
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**05**
4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**08**
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	**05**
6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	**Detailed Contents**	**Hrs**
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design	07

	4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO7016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	**Detailed Contents**	**Hrs**
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8

05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	Introduction **1.1** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06

04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. ‘Disaster Management’ by Harsh K.Gupta, Universities Press Publications.
2. ‘Disaster Management: An Appraisal of Institutional Mechanisms in India’ by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. ‘Introduction to International Disaster Management’ by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. ‘Disaster Management Handbook’ by Jack Pinkowski, CRC Press Taylor and Francis group.
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	**Development Engineering**	**03**

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Detailed Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people’s participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	**04**
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**

04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
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40% but excluding contents covered in Test I)

End Semester Examination:
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1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
MEL701	**DESIGN OF MECHANICAL SYSTEMS**	**01**

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps
3. 3To familiarize with the standard codes of professional practices in designing the various systems

Outcomes: Upon successful completion of this course, the learner will be able to …

1. Apply the concept of system design.
2. Design of Gear box.
3. Design of hoisting mechanism of EOT crane,
4. Design belt conveyor systems
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design pumps for the given applications

Term Work:	**Comprises of Part - A & Part -B**
Module	**Details**
Part A	**1. DESIGN AND DETAILED ASSEMBLY DRAWING :**
	a) Computer aided Design and detailed assembly drawing (**A3 size sheets)** of **any one** design problem, from any CAD software
	i) Design of hoisting mechanisms
	ii) Design of belt conveyors
	iii) Design of Engine
	b) Design and detailed assembly drawing (Full Imperial drawing sheet 762x559 mm) of **any one** design problem from the following:
	i) Design of Gear box
	ii) Design of pumps
	2. COURSE PROJECT :
	Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected. Course project may be given as development of software program using python, VB, C++, EXCEL etc for mechanical systems
Part B	**ASSIGNMENT :**
	Exercises on following topics in the form of design calculations with sketches and / or drawings.
	1. Methodology & Morphology of design
	2. Design of gearbox (As mentioned in theory)
	3. Design of Hoisting mechanism
	4. Design of Belt conveyor

	5. Engine design (SI/CI engine)
	6. Design of Pump
	The distribution of marks for term work shall be as follows:
	Exercises and Drawing sheets : 10 marks.
	Assignments : 05 marks
	Course Project : 05 marks.
	Attendance : 05 Marks.
	ASSESSMENT :
	End Semester Practical/Oral examination:
	1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
	2. Distribution of marks for practical-oral examination shall be as follows:
	Design Task : 15 marks
	Oral : 10 marks
	3. Evaluation of practical/oral examination to be done based on the performance of design task
	4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL702	**Maintenance Engineering Lab**	**1**

Objectives

1. To familiarize with Maintenance Procedures and Strategies.
2. To acquaint with the process of Condition Monitoring and Machinery Fault Diagnosis.

Outcomes: Learner will be able to….

1. Identify different tools used for maintenance.
2. Apply different maintenance strategies.
3. Demonstrate the process of servicing a machine.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Sr. No.	**List of Exercises**
1.	Identifications of different Tools used for maintenance (Spanner, Plier, Screw Driver, Allen Keys, Puller etc.)
2.	Dismantling and assembly of any one mechanical system (Gearbox, pumps, Injector, Fuel Pump, Tailstock etc.) (One job in a group of 4-5 students)
3.	Case studies based on Maintenance strategies (Breakdown, preventive, predictive and proactive)
4.	Machinery Servicing (Greasing, Oiling, Cleaning etc.)
5.	Condition Monitoring and Machinery Fault Diagnosis – Unbalance
6.	Condition Monitoring and Machinery Fault Diagnosis – Misalignment
7.	Condition Monitoring and Machinery Fault Diagnosis – Bent Shaft
8.	Condition Monitoring and Machinery Fault Diagnosis – Mechanical Looseness
9.	Condition Monitoring and Machinery Fault Diagnosis – Bearing Defects
10.	Condition Monitoring and Machinery Fault Diagnosis – Defects in gears
11.	Condition Monitoring and Machinery Fault Diagnosis – Defects in pumps
12.	Condition Monitoring and Machinery Fault Diagnosis – Defects in fans
13.	Condition Monitoring and Machinery Fault Diagnosis – Defects in blowers

Note :

1. **First four experiments are mandatory. At least four experiments to be performed from the remaining.**
2. **A visit of students to an automobile service station/any other machinery maintenance workshop shall be arranged as a part of the above exercises.**

Assessment:

Distribution of marks for term work

Laboratory work	20 Marks
Attendance	05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
    a. Practical performance 15 marks
    b. Viva 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination.

References:

1. A.R. Mohanty, "Machine Condition Monitoring: Principles and Practices", CRC Press
2. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and Hall

NPTEL

https://nptel.ac.in/courses/112105232 – Machinery Fault Diagnosis and Signal Processing, IIT Kharagpur

Course Code	Course Name	Credits
MEL703	**Industrial Skills**	**01**

Course Rationale: This course has been designed to prepare final year mechanical engineering students for placements, as well as to build computer skills and advanced soft skillsto make them ready for a career in the industry.

Objectives:

1. To familiarise mechanical engineering students with basiccomputer/IT skillsin the industry.
2. To practise soft skills and communication to be industry-ready.
3. To inculcate critical thinking and problem-solving abilities for efficient team and project outcomes.
4. To be prepared for campus placements by practising aptitude, logical reasoning, Group discussion and personal interview rounds.

Outcomes: At the end of the course, **the learners will be able to**

1. Skilfully prepare and edit documents and slides on MS Word and MS PowerPoint etc.
2. Execute functions on MS Excel.
3. Learn how to navigate tasks and execute functions in G-suite.
4. Understand and practice metacognitive skillsof creativity and problem solving.
5. Hone team building and leadership skills.

Perform well in campus placement rounds by practising Aptitude, Logical reasoning, Group Discussion and Personal Interviews.

Module	**List of Experiments and Activities**	**No. of La sessions (*2hrs)**
1	**Computer/IT skills**	6
1.1 1.2 1.2.1 1.2.2 1.2.3	Basics of Computers- Desktop/Laptop operations Microsoft Office • **MS Word**- Assignment to Create and use various commands in a Word document (Page setup, text formatting, templates, SmartArt, Title and Ribbon bar, Editing etc.) • **MS Excel**- Assignment to Create and tabulate a spreadsheet (Excel- data analysis, charts, pivot tables, VBA, etc.) • **MS- Power point**- Assignment to design and use a Presentation Software(MSPPT, Prezi, etc. – Presentation	

 1.2.4 1.3 1.4	design, templates, custom slides, animation, graphs, charts, troubleshooting etc.) • **MS Outlook** (Navigation, archiving, tasks distribution, filters, scheduling etc.) • G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.) • An introduction to the typesetting package LATEX.	
2	**Aptitude and Logical Reasoning**	2
2.1 2.2	Aptitude – Aptitude training, types of questions, mock tests Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	**Developing Metacognitive skills**	2
3.1 3.2	Task orientation and Goal setting (can be based on Final year Project): Creativity and Problem-solving	
4	**Collaborative Techniques:Team building skills**	1
4.1 4.2	Activities on Team building Case studies on Leadership, Decision making and Team building	
5	**GD – PI**	2
5.1 5.2	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based Personal Interview–Types of Interview Questions, Strategies, Sample answers, Mock Interviews	

Assignments: Assignments and activities should enable a steady progress in developing the aforementioned skills.A record of the conducted activities can be attached in journal as image printouts, and write up of case studies.

1. Application of MS Office skills (Individual)
    - Create and edit Word documents
    - Create and execute MS Excel functions
    - Create and enhance MS PPT
2. Writing a simple document in LATEX editor and running the typesetter program to produce finished document
3. Aptitude and Logical reasoning tests/practice sheets

4. Team building skills: Activities/Tasks to be performed as a team of 3 or 4 students.
5. Group Discussions

Case studies on problem-solving to be done as a team activity.

Personal Interview questionslog book

Assessment: Total – 50 Marks

Marks distribution will be as follows:

FINAL TERM WORK – 25 Marks

Assignments (Journal) – 20 Marks

Attendance - 05 Marks

ORALS/Written – 25 Marks

1. **Aptitude Test (Written) - 15 Marks**
2. **Mock Interview (Orals) – 10 Marks**

Books recommended/References/ Resources:

1. Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
2. Claudyne Wilder. *The Presentations Kit*: 10 steps for Selling Your Ideas, John Wiley & Sons, 1994.
3. Lesikar, Flatley. *Basic Business Communication*: Skills for Empowering the Internet Generation, Tata McGraw Hill, 2008.
4. Flavell, J. H. *Cognitive development*: Past, present, and future. 1992.
5. Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7th edition Amazon)
6. Thorpe, Edgar. *Test of Reasoning*: for All Competitive Examination. 7th edition., Amazon
7. Sinha, Nishit K., *Reasoning*, Pearson.
8. Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
9. Weblinks - https://cambridge-community.org.uk/professional-development/gswmeta/index.html
10. Various Quantitative aptitude books and websites listhttps://eduly.in/best-quantitative-aptitude-books/
    https://prepinsta.com/learn-aptitude/
    https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup

NPTEL

Creativityhttps://nptel.ac.in/courses/109101017

Course Era

MS Excelhttps://www.coursera.org/projects/introduction-microsoft-excel
G-suite https://www.coursera.org/projects/collaborating-g-suite-apps
Problem solving https://www.coursera.org/learn/problem-solving
Udemy
G-suite https://www.udemy.com/course/learn-gsuite/

Course Code	Course Name	Credits
MEP701	**Major Project 1**	**03**

Objectives: The course aims:	
The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.	
Outcomes:	
1	Students will be able to develop the understanding of the problem domain through extensive review of literature.
2	Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3	Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	Students will be able to design solutions for real-time problems that will positively impact society and environment..
5	Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6	Students will be able to inculcate professional and ethical behavior..

Guidelines:

1. **Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
  - Project orientation can be given at the end of sixth semester.
  - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
  - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
  - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
  - **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.

  - **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
  - Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staffalong with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and studentshave to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. **Project Report Format:**

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
  - General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
  - Architectural View
  - Algorithms/ Methodology
- Experimental Set up
  - Details of Database or details about input to systemsor selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Set up
- Implementation Plan for Next Semester
  - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

Desirable

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

3.Term Work:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Project Work Contribution
c. Project Report (Spiral Bound) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Term work evaluation:**

Term work evaluation for Project 1 should be conducted by Internal examiner on continuous basis throughout the semester.

Suggested quality evaluation parameters are as follows:

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work

Course Code	Course Name	Credits
MEC801	**Operations Planning and Control**	**03**

Objectives:

1. To provide an exposure to Operations Planning & Control (PPC) and its significance in manufacturing and service organizations
2. To appraise about need and benefits of planning functions related to products and processes
3. To provide exposure to production scheduling, sequencing and project management so as to optimize resources
4. To provide insights into MRP and ERP to minimize the total cost and to manage operations functions in a better way
5. To demonstrate different techniques used for facility planning and assembly line balancing
6. To develop an understanding of JIT, Lean, Agile and Synchronous Manufacturing system

Outcomes: Learner will be able to…

1. Illustrate operations functions and manage operations in a better way.
2. Apply various strategies to develop aggregate production plan based on the demand forecasting.
3. Apply various algorithms in scheduling and sequencing of manufacturing and service operations
4. Develop Material Requirements Plans (MRP) to estimate the planned order releases.
5. Apply various techniques for facility layout planning and line balancing to optimize the resources
6. Demonstrate the importance of implementation of JIT, Lean, Agile and Synchronous manufacturing in manufacturing and service organizations.

Module	Contents	Hours
1	**1.1 Introduction:** Production and Operations Function, Production systems, Make to stock, Make to order, Assemble to order and Engineer to order, type of layouts, Phases in OPC like Preplanning, Planning, Action & Control. **1.2 Strategic Planning for Operations and Services:** Approaches like Forced Choice model and Operations Model, Quality and Productivity strategy, Technology strategy. Operations Strategies for Services, Types or Service Operations: Quasi manufacturing, Customer as participants, Customer as product, Classification of Services, Service capacity.	**06**
2	**2.1 Forecasting:**Forecasting and Prediction, Need for forecasting, role of forecasting in OPC, Methods of forecasting, Qualitative methods, Quantitative methods like time series analysis, least square method, moving average method, and exponential smoothing method. Forecasting Error; Mean Absolute Deviation, Forecasting Bias **2.2 Capacity Planning:** Measurement of capacity, Measures of operating capacity, Factors influencing effective capacity, factors favouring over capacity and under capacity, short range, medium range and long range capacity planning. Capacity requirement Planning (CRP)	**08**

	2.3 Aggregate planning: Concept of aggregate planning, Pure Strategy; Mixed Strategy; Level Strategy, Rough cut capacity planning, Aggregate planning for Services; Optimal Models for Aggregate Planning; Linear Programming; Linear Decision Rules Master Production Schedule	
3	**3.1 Job shop/Intermittent Manufacturing Scheduling:** Factors influencing scheduling, Inputs for scheduling, Forward Scheduling, Backward Scheduling, Stages in Scheduling: Product sequencing, Loading and Dispatching, dispatching, progress report & expediting and control. Basic scheduling problems, Priority Sequencing, Gantt Charts, Johnson's Rule for optimal sequence of N jobs on 2 machine. Process N Jobs on 3 Machines (N/3 problem) and Jackson Algorithm. Processing of 2 Jobs on M Machine (2/M) problem, **3.2 Project scheduling:** Network analysis - PERT & CPM, cost analysis & crashing, resource leveling and smoothening.	**08**
4	**4.1 Material Requirement Planning:**Introduction, Limitations of conventional EOQ, Objectives of MRP, Inputs of MRP-I, Outputs of MRP, MRP lot sizing and Estimation of planned order releases, Manufacturing resource planning (MRP-II) **4.2 Enterprise Resource Planning (ERP):** Evolution, features, purpose of modeling an enterprise, ERP model for OPC, Modules in ERP, ERP Implementation Life Cycle, ERP packages like SAP-R3/Baan/PeopleSoft,	**06**
5	**5.1 Facility layout planning:** Factors influencing Plant Layout, Material Flow Patterns, Tools and Techniques used for Plant Layout Planning. **5.2 Line Balancing:** Objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	**06**
6	Introduction to JIT system, Lean, Agile and Synchronous manufacturing: Concept, Characteristics, Components and Implementation.	**05**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books: -

1. "Production and Operations Management", K. Aswathappa & K. Shridhara Rao, Himalaya Publishing House, Revised 2nd Edition (2008)
2. "Industrial Engineering and Production Management", Martand Telsang, S. Chand, New Delhi (2009)
3. "Modern Production operations Management", Elwood S Buffa and Rakesh K Sarin, 8th Edition,Wiley Eastern, New York (1999) ISBN: 978-0471819059
4. "Production and Operations Management", Panneer Selvan R, 3rd Edition 2002Prentice Hall India, New Delhi, ISBN: 978-8120345553
5. "Production Planning and Control", Samuel Eilon, Universal Publication, ISBN: 9788185027548
6. "Production Planning and Control", L C Jhamb ,12th Edition 2010, Everest Pub House.
7. "Production Planning and Control", W. Boltan-Longman Scientific & Technical(1994), ISBN: 978-0582228207
8. "Production Systems- Planning, Analysis & Control", James. L. Riggs,John, 4th Edition 1987, Wiley & Sons, ISBN: 9780471847939
9. Manufacturing Planning and Control Systems, Thomas E. Vollman, William L. Berry & Others,4th Edition 1997, McGraw Hill Pub, ISBN: 978-0786312092
10. "Manufacturing Process Planning and Systems Engineering", Anand Bewoor, Dreamtech Press 2009, ISBN: 978-8177229967
11. "Production and Operations Management", S.N. Chary, 3rd Edition 2004, TMH publishing company, ISBN: 978-0070583559
12. Modernization & Material Management, L.C. Jhamb - Everest Publishing House

Course Code	Course Name	Credits
MEDLO8051	**Composite Materials**	**03**

Objectives

1. To study the manufacturing methods of composite material.
2. To study the behaviour of composite materials, both at micro and macro levels.
3. To study the procedure of designing a composite laminate and structure as a whole for the given application.
4. To study the applicability of composite materials for various industrial/loading applications
5. To study the damage detection and damage repair methods for composite materials

Outcomes: Learner will be able to…

1. Select the type of material for the fibres and matrix in a composite material for the given application.
2. Relate stresses and strains through the elastic constants for a given lamina.
3. Evaluate elastic properties of a lamina based on the properties of its constituents.
4. Predict failure of a lamina under the given loading condition.
5. Select the number of laminae and their stacking sequence in a composite material for the given loading condition.
6. Identify the type of damage occurring in a composite structure and select an appropriate method to repair it.

Module	Contents	Hours
1	**Introduction** Classifications based on fibres and matrix, Advantages, Applications, Terminology, Manufacturing Methods: Hand layup, Spray layup, Vacuum bagging, Prepregs, Industrial autoclave, Filament winding, Pultrusion, Resin transfer moulding, Vacuum Infusion Processing, Powder metallurgy route for ceramic and metal matrix composites	**08**
2	**Analysis of Lamina** Hooke’s law for different types of materials, Plane stress assumption, Hooke’s law for a two-dimensional unidirectional lamina, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina, Hooke’s law for a two-dimensional angle lamina, Engineering constants of an angle lamina	**06**
3	**Lamina Failure Theories** Introduction, Maximum stress failure theory, Maximum strain failure theory, Tsai- Hill failure theory, Tsai-Wu failure theory, Strength ratio, Failure envelopes	**04**
4	**Introduction to Micromechanics of Lamina and Laminate Design** Prediction of mechanical properties of lamina based on properties of its constituents (fibre and matrix), Laminate types and their codes, Overview of laminate design (no problems on this topic)	**06**

5	**Inspection of Composites** Different types of damages in composites, Non-destructive testing of composites: Ultrasonics inspection, Acoustography, Low frequency Methods, Radiographic inspection, Shearography, Acoustic emission, Thermography	**06**
6	**Repair of Composites** Restitution and repair of composites: Selection of Repair method, Repair criteria, Generic repair designs, Matrix cracks, Delamination, Holes and Fiber fracture, Damage removal and surface preparation	**06**

Text Books:

1. M.Balasubramanian, “Composites materials processing” ,1st edition, CRC press 2013.
2. A.K. Kaw, “Mechanics of Composite Materials”, Taylor and Francis Group, ISBN: 9780815351481
3. Ajay Kapadia, “Non Destructive Testing of Composite Materials”, National Composites Network
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.

References:

1. R.M. Jones, “Mechanics of Composite Materials”, 2nd Edition,Taylor and Francis, Inc,ISBN: 9781138571075
2. I.M. Daniel and O. Isai, “Engineering Mechanics of Composite Materials”, 2nd Edition 2005,Oxford University Press, ISBN: 9780195150971
3. D. Gay, S.V. Hoe, and S.W. Tsai, “Composite Materials: Design and Applications”, 3rd Edition 2014, CRC Press, ISBN: 978-1466584877
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.
5. M.M. Schwartz, “Composite Materials: Properties, Nondestructive Testing, and Repair”, Prentice Hall PTR (1997), ISBN: 9780133000474

Course Code	Course Name	Credits
MEDLO8052	**Smart Materials**	**03**

Objectives

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials

Outcomes: Learner will be able to…

1 Classify and select different types of smart materials
2. Comprehend Important Concepts and principles of Smart Materials
3. synthesis, sensing and actuation of Piezoelectric Materials, Magneto strictive Materials, Shape Memory Alloys, Electroactive Polymers
4 synthesis, sensing and actuation of Ferrofluids and Magneto rheological Fluids, Soft Matter, Carbon Nanotubes and Carbon nanostructures, Thermoelectric Materials
5. Classify and select Smart Materials for Energy Applications: Materials used for energy storage
6 Classify and select Composite Materials, Nano Composite Materials

Module	Contents	Hours
1	**Introduction to Smart Materials:** Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS), Nano Composite Materials	**07**
2	**Important Concepts of Smart Materials:** artificial skins, artificial muscles, biomimetic materials, materials with tuneable responses, non-linear properties, self-healing materials, adaptive structures, self-replicating materials/structures, self-assembly, inch worm devices, hysteresis, integrated sensing and actuation	**08**
3	**Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc)** 1. Piezoelectric Materials 2. Magneto strictive Materials 3. Shape Memory Alloys 4. Electroactive Polymers	**06**
4	**Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications** 1. Ferrofluids and Magneto rheological Fluids and applications in dampers 2. Soft Matter and its applications as smart skins, smart textiles etc 3. Carbon Nanotubes and Carbon nanostructures and its applications 4. Thermoelectric Materials and Peltier devices	**06**

5	**Smart Materials for Energy Applications:** Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	**06**
6	**Manufacturing techniques for smart materials:** micromanufacturing, high resolution lithography, LIGA process, Generative manufacturing processes such as STL, SLS, SPB, BPM, LOM, SGC, FDM, BIS, BPM, Self-assembly process, Ion beam processes,	**06**

Assessment:

Internal Assessment for 20 marks: Consisting of Two Compulsory Class Tests.

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. M.V. Gandhi and B.S. Thompson, “Smart Materials and Structures”, Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Scwartz, “Encyclopedia of Smart Materials Vol. I and II”, John Wiley & Sons
3. SenolUtku, “Theory of Adaptive Structures : Incorporating Intelligence into Engineered Products”, CRC Press (1998), ISBN: 9780849374319
4. A.V. Srinivasan, “Smart Structures: Analysis and Design”, Cambridge University Press,Cambridge; New York, 2001 (ISBN: 0521650267)
5. G. Gautschi, “Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers”, Springer, Berlin; New York, 2002 (ISBN:3540422595)
7. K. Uchino, “Piezoelectric Actuators and Ultrasonic Motors”, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
8. G. Engdahl, “Handbook of Giant Magneto strictive Materials”, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
9. K. Otsuka and C.M. Wayman, “Shape Memory Materials”, Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
10. Eric Udd, “Fibre Optic Sensors: An Introduction for Engineers and Scientists”, John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
11. André Preumont, “Vibration Control of Active Structures: An Introduction”, 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
12. HojjatAdeli, “Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future”, John Wiley, New York, 1999 (ISBN: 047135094X)
13. T.T. Soong, “Passive Energy Dissipation Systems in Structural Engineering”, Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

14. V.K. Wadhawan, Smart Structures: Blurring the Distinction Between the Living and Non-living , Oxford University Press, Oxford (2007) ISBN: 9780199229178
15. H.T. Banks, R.C. Smith and Y Wang, “Smart Structures: Modelling, Estimation and Control”, Wiley, New York (1996)
16. Shape Memory Alloys, (ed) D.C. Lagoudas, Springer Science (2008)
17. S.K. Ghosh , “Self-healing Materials: Fundamentals, Design Strategies and Applications, Wiley-VCH Verlag GmbH and Co. (2009), ISBN: 978-3-527-31829-2
18. Kwang J KIm and Satoshi Tadokore, “Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors”, Springer-Verlag, London (2007) ISBN: 9781846283710
19. S Priya and D J Inman, “Energy Harvesting Technologies”, Springer-Verlag (2008) ISBN: 978-0-387-76463-4
20. MoriakiWakaki, “Optical Materials and Applications”, CRC Press (2012) ISBN: 9781315221403
21. S.S. Ray and M Bousmina, “Polymer Nanocomposites and their Applications”, American Scientific Publishers (2008)

Course Code	Course Name	Credits
MEDO8053	**Micro Electro Mechanical Systems (MEMS)**	**03**

Objectives:

1. To realize the benefits and effects of scaling.
2. To understand properties and crystallography of Silicon
3. To learn the microfabrication techniques
4. To understand the principles and uses of micro systems

Outcomes:

After taking this course, learner should be able to:

1. Apply laws of scaling for development of a MEMS device
2. Understand the materials and their processing to make MEMS
3. Select and use microfabrication techniques for microsystems
4. Understand the development of micro sensors and actuators
5. Analyze microsystems technology for technical feasibility as well as practicality
6. Develop useful applications of MEMS.

Module	Contents	Hours
1	**Introduction to MEMS** Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystem Products, Scaling effects - scaling laws in miniaturization- Application of MEMS	**05**
2	**Material for MEMS and manufacturing** Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.	**07**
3	**Micro-fabrication methods** LIGA and other moulding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing.	**06**
4	**MEMS components-micro sensors** Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical microsensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors;	**08**
5	**Micro-actuators** Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.	**06**
6	Case studies /research based on MEMS applications-impact of materials, processes and design, Actuation using Shape Memory Alloys, Medical device, micropumps	**04**

Text books:

1. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu, Tata McGraw-Hill Publishing Company Ltd.
2. Foundation of MEMS by Chang Liu, Pearson Education

References:

1. Fundamentals of Microfabrication and Nanotechnology, by Marc J. Madou, CRC Press, 2011,ISBN: 9780849331800
2. Micromachined Transducers Sourcebook, by Gregory Kovacs, WCB McGraw-Hill, Boston, 1998, ISBN: 9780071164627
3. Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, by M.H. Bao, Elsevier, New York, 2000, ISBN: 978-0444505583
4. Microsystem Design, by Stephen D Senturia, Springer Publication, 2000, ISBN: 9780792372462.
5. Micro sensors - Principles and Applications, by Julian W. Gardner, John Wiley & Sons, Inc.1994, ISBN: 9780471941361.

Course Code	Course Name	Credits
MEDLO8061	**Product Design and Development**	**03**

Objectives:

1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
2. To demonstrate an understanding of the overview of all the product design & development processes.
3. To demonstrate knowledge of concept generation and the selection of tools.
4. To study the applicability of product design & development in industrial applications.

Outcomes: Upon satisfactory completion of this course, the student will be able to:

1. Describe the process of product design & development.
2. Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
3. Create 3D solid models of mechanical components using CAD software.
4. Demonstrate individual skills using selected manufacturing techniques such as rapid prototyping.
5. Fabricate an electromechanical assembly of a product from engineering drawings.
6. Work collaboratively in a team to complete a design project.
7. Effectively communicate the results of projects and other assignments both in a written and oral format.

Module	Details	Hours
01	Need for developing products, The importance of Engineering and Industrial design, The design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Generic product development process, Various phases of product development, Planning for products, Establishing markets - market segments - relevance of market research.	**7**
02	The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Embodiment design, Product architecture, and Steps in developing product architecture.	**7**
03	Identifying customer needs, Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	**7**
04	Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gorden technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic methods of designing.	**7**

05	Industrial design, Basic forms & elements, Integrating basic forms & elements such as balance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.	**7**
06	Concept of Design for Manufacturing and Assembly (DFMA). Role of computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused disposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).	**7**

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.

2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.

2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.

3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Course Code	Course Name	Credits
MELO8062	**Design for X**	**03**

Objectives:

1. To acquaint the learners with the concept of designformanufacturing and assembly
2. To acquaint the learners with the concept ofdesignfor reliability and maintainability
3. To study the product development economics.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Applydesignconcepts and guidelines formanufacturing and assembly.
2. Demonstrate the concept of value analysis and its relevance.
3. Understand the economics of product development
4. Applydesignconceptsforreliability and maintainability

Module	Contents	Hours
1.	**DESIGNFORMANUFACTURE**: General design principles for manufacturability-strength and mechanical factors, mechanisms selection, evaluation method, Processcapability-Feature tolerances-Geometrictolerances-Assembly limits—Datum features-Tolerance stacks	05
2.	**DESIGN FOR ASSEMBLY:** Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines	08
3.	**VALUEENGINEERING:** Introduction to Value Engineering and Value Analysis, Valuetypes-functional—operational—aesthetic, Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies.	08
4.	**PRODUCTDEVELOPMENTECONOMICS:** Elements of Economics Analysis-Quantitative and qualitative analysis-Economic Analysis Process-Estimating magnitude and time of future cash inflows and outflows-	08

	Sensitivity analysis-Projecttrade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success	
5.	**CONCEPTOFRELIABILITY:** Introduction:The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution:The reliability Function, Mean Time to Failure, Hazard Rate Function, Bathtub Curve, Conditional Reliability	05
6.	**MAINTAINABILITY:** Analysis of down time, Report Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependant System with Repair, Design for Maintainability.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. HarryPeck,DesigningforManufacture,PitmanPublications,1983.
2. GeorgeEDieter,EngineeringDesign,McGraw-HillInt Editions,2000
3. S.S.Iyer,ValueEngineering,NewAgeInternational, 2000
4. CharlesE.Ebeling,AnIntroductiontoReliabilityandMaintainabilityEngineering,TMH2000.

Course Code	Course Name	Credits
MEDLO8063	**Total Quality Management**	**03**

Objectives:

1. To understand the importance of Quality Management and principles of TQM
2. To understand seven basic QC tools and advanced QM tools
3. To understand the concept of Statistical Quality Control
4. To understand the concept of Continuous Improvement and TQM implementation
5. To understand different Quality Systems and Quality Standards
6. To understand the future trends in TQM and TQM strategies

Outcomes: The students will be able to use the tools and techniques of TQM in the manufacturing and service sectors.

1. To apply QM and principles of TQM in organizational development process.
2. To apply the QC & QM tools in process improvement.
3. To apply SQC techniques to improve process quality.
4. To apply Six Sigma project in TQM Implementation
5. To apply QMS and Certification for Quality Accreditation
6. To apply the advanced tools for Quality Sustainability.

Module	Contents	Hours
1	**Introduction to Quality Management :** **A)** Definitions of Quality, product quality and service quality; the evolution of quality; need for Quality Management, Quality statements and Policy, Customer orientation & satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating & selection, CSI, Costs of Quality, Prevention , appraisal and failure aspects , Use of COQ for improving quality and performance, Designing for quality, Quality of design, Quality of conformance. B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Triology , PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning; Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognition and reward, performance appraisal.	**08**
2	**QC Tools :** A) **Seven QC Tools:** Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram, Process Flow Chart. B) **Seven QM Tools:** Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product, Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing)	**06**

3	**Statistical Quality Control:** 100% Inspection versus Sampling Inspection, Reasons for SQC. **A) Acceptance Sampling:** Concept of Producer Risk and Consumers Risk. Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan. Design Sampling Plan on the basis of MIL, ASQ Standards. **B) Statistical Process Control:** Variations – Concept, Causes – Random & Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) & Process Capability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.	**06**
4	**A) Continuous Improvement:** Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM- concepts, 5S, Kaizen, FMEA- stages, Zero Defect. **B) TQM Implementation:** Manufacturing and Service sectors, Introduction to Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach & DMAIC Approach, Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com.	**08**
5	**Quality Management System & Certification:** **A) QMS:** Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5th Edition), Introduction to TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000. **B) Quality Awards:** Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.	**06**
6	**Future Trends in TQM :** Strategic approach to leadership , Customer centric endeavors , Involvement & empowerment of all employees / stake holders , Decision making based on real time facts , Win-Win policy with suppliers , New paradigms of Green & sustainability , TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics.	**06**

Text Books:

1. Besterfield D.H. et al.: Total quality Management, 3rd Edition, Pearson Education Asia, 2006.
2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2006.
3. Poornima M. Charantimath: Total Quality Management, 2nd Edition, Pearson Education Asia, 2006.
4. N. Logothetis: Managing for Total Quality, 6th Edition, Prentice Hall of India Pvt. Ltd. 2003.
5. Suganthi L. and Samuel A.: Total Quality Management, Prentice Hall India, 2006.
6. Evans J.R. and Lindsay W.M.: The Management and Control of Quality, 8th Edition, 1st Indian Edition, Cengage Learning, 2012.

Reference Books:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

Course Code	Course Name	Credits
ILO8021	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6

05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management,Gido Clements, Cengage Learning
4. Project Management,Gopalan, Wiley India
5. Project Management,Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	**Entrepreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs
4.

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08

06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today’s emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	6

	- Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. - Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning** - Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale - Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning - Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design	**08**

	f. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08

06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company

13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency

14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET

15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO 8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06

4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan

8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
MEL801	**Product Design and Development**	**01**

Objectives:

1. To familiarize concepts in PD&D for practical implementation
2. To acquaint with the applicability of PD&D in industrial applications

Outcomes: Learner will be able to…

1. Identify the need for developing products
2. Select suitable PD&D processes
3. apply the creativity & industrial design methods to design & develop the chosen product
4. Work collaboratively in a team to complete a PD&D project.
5. Effectively communicate the results of projects and other assignments both in a written and oral format.

Assignments:

Total 3 to 4 assignments have to be given.

Assignments III and IV are compulsory and shall be treated like mini-projects. Two more could be covered from the remaining as case studies.

I. Based on Module No. 1 and 2.

1. Select any one consumer product, such as
    a) a mobile
    b) a laptop
    c) a pencil sharpener
    d) a table and chair
    e) a stool
    f) a bicycle
    g) a pen
    h) a storage device of any household items
    i) a cupboard etc.…. anything

Assume that you want to go for re-development of any one of the products. How would you tackle by answering any 3 or 4 points that are given below? Q1. How do you identify the need for developing the product?

Q2. What are the changes that you would like to incorporate?

Q3. Would it be Engineering Design or Industrial design factors or both? Q4.

What are the generic PD&D processes that you would like to adopt? Q5. What
are the methods that you would adopt for Market research?
Q6. If you would like to develop which design process you would like to adopt?
Q7. If you select descriptive design… then why? If you select prescriptive design… then why? Q8.
What are the steps that you would like to adopt while developing the product?

II. Based on Module No. 3.

2. Select any one consumer product, such as
   a) a mobile
   b) a laptop
   c) a pencil sharpener
   d) a table and chair
   e) a stool
   f) a bicycle
   g) a pen
   h) a storage device of any household items
   i) a cupboard etc.…. anything

Assume that you want to go for re-development of any one of the above products.
How would you tackle by answering any 3 or 4 points that are given below?
Q1. How do you identify the customer needs for developing the product?

Q2. How do you ascertain/select the attributes that are to be tackled?

Q3. Would you like to go for Engineering Design factors or Industrial design factors or both?
Q4. How do you develop a correlation matrix?
Q5. How do you “Construct House of Quality”?
Q6. What are the generic PD&D processes that you would like to adopt in re-designing it using House of quality?
Q7. What are the methods that you would adopt for Market acceptance? Q8.
How do you document the entire design process?

III. Based on Module No. 4.

3. Select any one consumer product, such as
   a) a mobile

  - b) a laptop
  - c) a pencil sharpener
  - d) a table and chair
  - e) a stool
  - f) a bicycle
  - g) a pen
  - h) a storage device of any household items
  - i) a cupboard etc…. anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the creativity method to design the chosen product using any one creativity methods? Develop the product and document the entire process by answering some of the questions as shown in I or II.

IV. Based on Module No. 5.

4. Select any one consumer product, such as
   - a) a mobile
   - b) a laptop
   - c) a pencil sharpener
   - d) a table and chair
   - e) a stool
   - f) a bicycle
   - g) a pen
   - h) a storage device of any household items
   - i) a cupboard etc…. anything

Assume that you want to go for re-development of any one of the above products.
How would you apply the principles of Industrial Design methods to design the chosen product? Develop the product and document the entire process by answering some of the questions as shown in I or II.

V. Based on Module No. 6.

5. Select any one consumer product, such as
   - a) a mobile
   - b) a laptop

c) a pencil sharpener
d) a table and chair
e) a stool
f) a bicycle
g) a pen
h) a storage device of any household items
i) a cupboard etc.…. anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of DFMA to design the chosen product? Develop the exploded view of the product and document the entire process by answering some of the questions as shown in I or II.

The distribution of marks for term work shall be as follows:

Assignments/Case studies:10 marks. Mini

Project:10 marks.

Attendance: 05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
    a) Practical performance ……**15** marks
    b) Oral ....**10** marks

Evaluation of practical examination to be done based on the practical performed.

Students work along with evaluation reports to be preserved till the next examination.

Text/Reference Books:

1. Baker, M. & Hart S. (2007), Product Strategy and Management, (2nd. Ed.) Edinburgh: Pearson Education.
2. Ulrich, K. & Eppinger, S. (2012), Product Design and Development. (5th. Ed.) Los Angeles: McGraw Hill Education.
3. Yousef Haik, T. M. M. Shahin (2010), Engineering Design Process, (2nd. Ed. Reprint), Cengage Learning, ISBN 0495668141.
4. Kevin Otto, Kristin Wood (2004), Product Design, (Indian Reprint), Pearson Education, ISBN 9788177588217.

Course Code	Course Name	Credits
MEL802	**Laboratory based on IoT**	**01**

Objectives:

1. To learn microcontroller programming using 8051 and Arduino Development Board.
2. To acquaint with interfacing of simple peripheral devices to a microcontroller.
3. To acquaint with exchange of data using wireless communication.
4. To familiarize with logging the data on cloud platform.

Outcomes: Learner will able to...

1. Develop simple applications using microcontrollers 8051 and Arduino.
2. Interface simple peripheral devices to a Microcontroller.
3. Use microcontroller based embedded platforms in IoT.
4. Use wireless peripherals for exchange of data.
5. Setup cloud platform and log sensor data.

List of Experiments:

1. Interfacing experiments using 8051 Trainer kit and interfacing modules
    a. display (LCD/LED/Seven Segment)
    b. Stepper / DC Motor
2. Introduction to Arduino platform and programming
3. Simple Applications using Arduino Development Board (Any two)
    a. Simple LED Blinking using development board
    b. Building IOT Smart Switch using IOT
    c. Pulse Width Modulation
    d. Analog to Digital / Digital to Analog Conversion
4. Interfacing Arduino with a Sensor (Any one): Temperature Sensor / PIR/ Ultrasonic sensor/ IR Sensor/ Flame Sensor/ MQ6 Sensor/ Humidity sensor/ Raindrop Sensor, magnetometers, cameras, accelerometers etc.
5. Interfacing Arduino with an Actuator (Any One): Motors / solenoids / Controllers etc.
6. Communication using Wireless Medium (Any One): WiFi / Bluetooth / Zigbee / RFID etc.
7. Setting up and Cloud Platform and logging Sensor Data on the platform.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned above.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral.

Course Code	Course Name	Credits
MEP801	**Major Project II**	**12**

Objectives::

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

Outcomes: Learner will able to

1 Students will be able to implement solutions for the selected problem by applying technical and professional skills.

2 Students will be able to analyze impact of solutions in societal and environmental context for sustainable development.

3 Students will be able to collaborate best practices along with effective use of modern tools.

4 Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.

5 Students will be able to nurture professional and ethical behavior.

6 Students will be able to gain expertise that helps in building lifelong learning experience.

Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. **Project Report Format:**

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective

- Proposed System
    - Analysis/Framework/ Algorithm
    - Design details
    - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
    - Details of Database or details about input to systems or selected data
    - Performance Evaluation Parameters (for Validation)
    - Software and Hardware Set up
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable

- Students should be encouraged
    - to participatein various project competition.
    - to write minimum one technical paper & publish in good journal.
    - to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Completeness of the project and Project Work Contribution
c. Project Report (Black Book) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral &Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as following:

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work

University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 183

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. AAMS(UG)/80 of 2021-22 dated 30th September, 2021, relating to the revised syllabus (Rev – 2019 'C' Scheme) for the B.E. in Mechanical Engineering (T.E. Sem V and VI) and AAMS(UG)/82 of 2021-22 dated 30th September, 2021, relating to the revised syllabus (Rev – 2019 'C' Scheme) for the B.E. in Automobile Engineering (T.E. Sem V and VI).

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31st May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.55 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.55 and that in accordance therewith, to replace the Subject **Design of Experiments (MEDLO5012/AEDLO5012)** for **B.E. (Mechanical & Automobile Engineering) Semester V** with a new subject **Statistical Techniques (MEDLO5012/AEDLO5012)**, as per appendix the change is necessitated because of the fact that exactly a similar course Design of Experiments (ILO7014) is being offered as an Institute Level Optional Course, the same is brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

2.12.22

(Prof. Sunil Bhirud)
I/c Registrar

MUMBAI – 400 032
29th November, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.55 (R)/11/07/2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Mechanical Engineering,
3) The Chairman, Board of Studies in Automobile Engineering,
4) The Director, Board of Examinations and Evaluation,
5) The Director, Board of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Co-ordinator, MKCL.

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

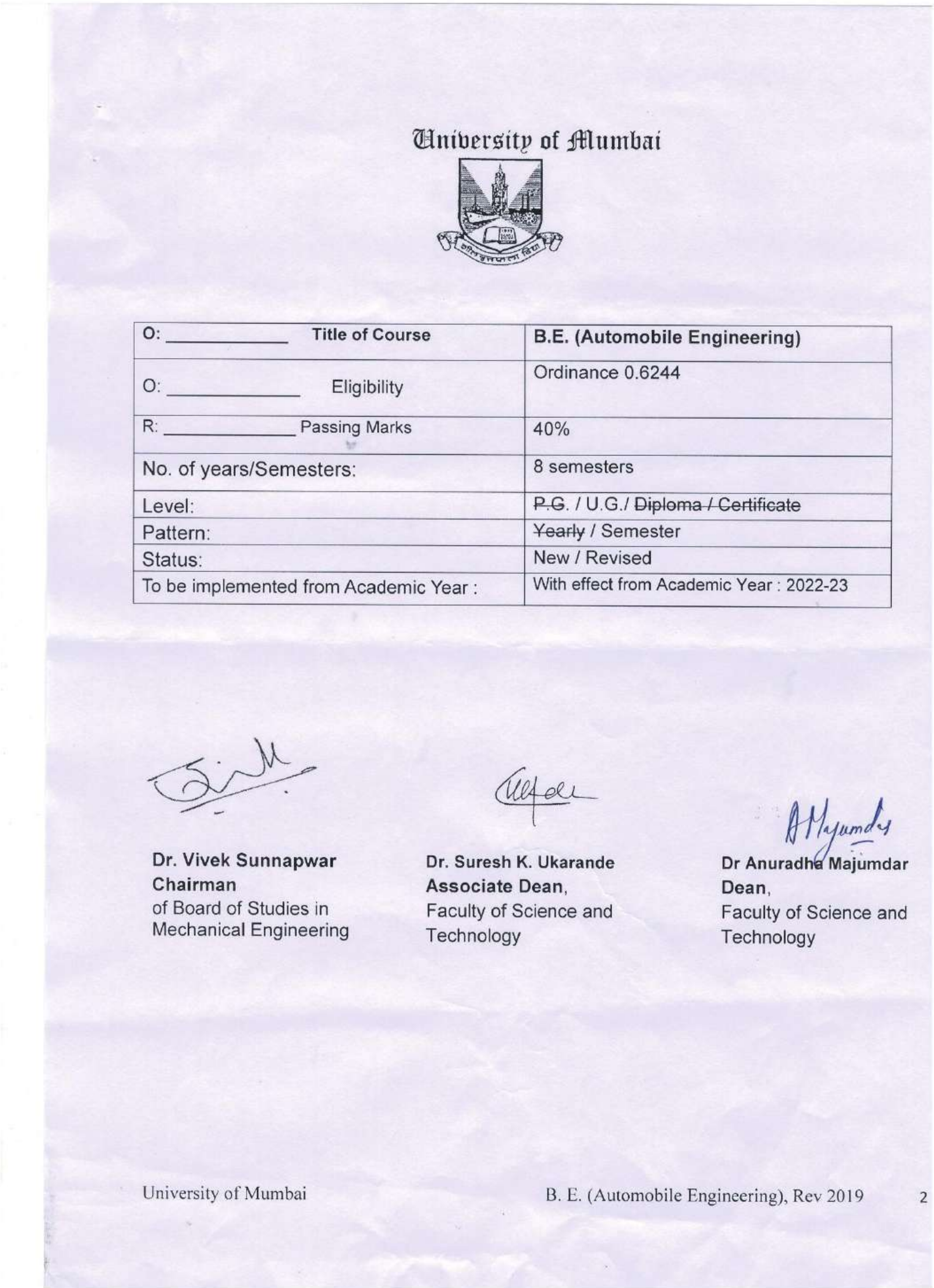
for information.

AC – 11 July, 2022
Item No. – 6.55 (R)

University of Mumbai

Revised Syllabus for
B.E.
(Automobile Engineering)
Semester – (V)
(Choice Based Credit System)

(With effect from the academic year 2022-23)



University of Mumbai

O: ____________ **Title of Course**	**B.E. (Automobile Engineering)**
O: ____________ Eligibility	Ordinance 0.6244
R: ____________ Passing Marks	40%
No. of years/Semesters:	8 semesters
Level:	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	New / Revised
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in
Mechanical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

A Majumdar

Dr Anuradha Majumdar
Dean,
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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
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Dr Anuradha Muzumdar
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Faculty of Science and Technology
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Preface

Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Automobile Engineering is one of the fastest growing sectors, with lots of inventions and innovations happening. The graduating Automobile Engineers can contribute in the areas such as engines, transmission, safety and stability, energy and alternate energy etc. The challenges for our budding engineers would be manifold, when electric vehicles are already gaining popularity and driverless cars becoming a reality.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives proposed for the undergraduate program in Automobile Engineering are listed below;

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To Prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering
Dr. Vivek K. Sunnapwar : Chairman
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Dr. S. S. Thipse : Member
Dr. Milind Deshmukh : Member

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC501	Mechanical Measurements & Controls #	3	--	3	--	3
AEC502	Internal Combustion Engines	3	--	3		3
AEC503	Machine Design	3	--	3	--	3
AEC504	Finite Element Analysis #	3	--	3	--	3
AEDLO501X	Department Level Optional Course – 1#	3	--	3	--	3
AEL501	Measurement and Engine Testing Lab	--	2	--	1	1
AEL502	Machine Design	--	2	--	1	1
AEL503	Finite Element Analysis#	--	2	--	1	1
AESBL501	Professional Communication and Ethics - II #	--	2*+2	--	2	2
AEPBL501	Mini Project – 2 A	--	4$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
AEC501	Mechanical Measurements & Controls #	20	20	20	80	3	--	--	100
AEC502	Internal Combustion Engines	20	20	20	80	3	--	--	100
AEC503	Machine Design	20	20	20	80	3	--	--	100
AEC504	Finite Element Analysis #	20	20	20	80	3	--	--	100
AEDLO501X	Department Level Optional Course – 1#	20	20	20	80	3	--	--	100
AEL501	Measurement and Engine Testing Lab	--	--	--	--	--	25	25	50
AEL502	Machine Design	--	--	--	--	--	25	--	50
AEL503	Finite Element Analysis#	--	--	--	--	--	25	25	50

AESBL501	Professional Communication and Ethics - II #	--	--	--	--	--	25	25	50
AEPBL501	Mini Project – 2 A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**100**	**725**

Department Level Optional Course – 1

Course Code	**Department Level Optional Course – 1**
AEDLO5011	Optimization Techniques#
AEDLO5012	Statistical Techniques#
AEDLO5013	Computational Methods#

*** Theory class to be conducted for full class**
$ indicates work load of Learner (Not Faculty), for Mini Project
# indicates common with Mechanical Engineering

Note: Students are required to undergo Internship (Garage Training) of minimum 4 weeks in vacation of Semester V.

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
AEC601	Automotive System Design	4	--	4	--	4
AEC602	Mechanical Vibrations	3	--	3		3
AEC603	Vehicle Body Engineering and Safety	3	--	3	--	3
AEC604	Automation and Artificial Intelligence #	3	--	3	--	3
AEDLO602X	Department Optional Course – 2#	3	--	3	--	3
AEL601	Automotive System Design	--	2	--	1	1
AEL602	Mechanical Vibrations	--	2	--	1	1
AEL603	Vehicle Body Engineering and Safety	--	2	--	1	1
AESBL601	Measurements & Automation #	--	4	--	2	2
AEPBL601	Mini Project – 2 B	--	4$	--	2	2
Total		**16**	**14**	**16**	**07**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
AEC601	Automotive System Design	20	20	20	80	3	--	--	100
AEC602	Mechanical Vibrations	20	20	20	80	3	--	--	100
AEC603	Vehicle Body Engineering and Safety	20	20	20	80	3	--	--	100
AEC604	Automation and Artificial Intelligence #	20	20	20	80	3	--	--	100
AEDLO602X	Department Level Optional Course – 2#	20	20	20	80	3	--	--	100
AEL601	Automotive System Design	--	--	--	--	--	25	25	50
AEL602	Mechanical Vibrations	--	--	--	--	--	25	--	25
AEL603	Vehicle Body Engineering and Safety	--	--	--	--	--	25	25	50

AESBL601	Measurements & Automation #	--	--	--	--	--	25	25	50
AEPBL601	Mini Project – 2 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**100**	**725**

Department Level Optional Course – 2

Course Code	**Department Level Optional Course – 2**
AEDLO6021	Press Tool Design#
AEDLO6022	Tool Engineering#
AEDLO6023	Metal Forming Technology#

$ indicates work load of Learner (Not Faculty), for Mini Project
# indicates common with Mechanical Engineering

Note: Students are required to undergo Internship (Garage Training) of minimum 4 weeks in vacation of Semester VI.

Course Code	Course Name	Credits
AEC501	**Mechanical Measurements and Controls**	**03**

Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.
5. To study concept of mathematical modelling of the control system.
6. To acquaint with control system under different time domain.

Outcomes: Learner will be able to…

1. Handle, operate and apply the precision measuring instruments / equipment's.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Classify and select proper measuring instrument for displacement, pressure, flow and temperature measurements.
5. Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability.

Module	Details	Hrs.
1	**1.1** Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization. **1.2** Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	**06**
2	**2.1** Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer. **2.2** Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. **2.3** Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer. **2.4** Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.	**08**
3	**3.1** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. **3.2** Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.	**06**
4	**4.1** Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper Transducer	**08**

	4.2 Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors **4.3** Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges **4.4** Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter **4.5** Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers	
5	**5.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **5.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra **5.3** Transient and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	**06**
6	**6.1** Stability analysis: Introduction to concepts of stability, The Routh criteria for stability **6.2** Experimental determination of frequency response, Stability analysis using Root locus, Bode plot	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering. Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal

6. Control System Engineering by Nagrath I.J. and Gopal M, Wiley EasternLtd.
7. Modem Control engineering: by K. Ogata, Prentice Hall
8. Control systems by Dhanesh Manik, Cengage Learning
9. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, Oxford University Press.
10. Instrumentation and Control System, W. Bolton, Elsevier
11. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
12. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
13. Mechanical Measurements by S P Venkateshan, John Wiley & Sons

NPTEL Courses
https://nptel.ac.in/courses/112/103/112103261/ - Principles of Mechanical Measurement, IIT Guwahati
https://nptel.ac.in/courses/112/107/112107242/ - Mechanical Measurement System, IIT Roorkee
https://nptel.ac.in/courses/112/106/112106138/ - Mechanical Measurements and Metrology, IIT Madras

Course Code	Course Name	Credits
AEC502	**Internal Combustion Engines**	**03**

Objectives:

1. To provide fundamental idea on Spark Ignition & Compression Ignition Engines.
2. To familiarise with the complexity in combustion processes.
3. To give clear concept of power generation and engine performance.
4. To gather clear knowledge on effects of emission and its control.
5. To acquaint with recent trends in Engine Technology.

Outcomes: Learner will be able to…

1. Explain the actual engine operation.
2. Analyse the combustion process in IC engines.
3. Illustrate different power boosting methods in IC Engines
4. Analyse operating parameters & performance of IC Engines.
5. Illustrate emission norms and emission control techniques.
6. Comprehend the recent trends in fuels and engines

Module	Details	Hrs
1	**Introduction** Classification of I.C. Engines, Parts of I.C. Engine and their materials, Atkinson Cycle and Miller Cycle, Fuel Air and Actual working cycles analysis, Valve Timing Diagram, LHR & VCR Engines, Homogeneous charge compression Ignition, Rotary Engine-Six stroke engine concept (No Numerical from this module)	04
2	**Spark Ignition Engines** **Fuel Supply System:** Automotive engine air-fuel mixture requirements, principle of carburetion & working (only introduction – No Numerical) Fuel Injection: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Schematic details and working of different types of Ignition systems in SI Engines **Combustion:** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Detonation and Knocking, Factors affecting combustion and detonation, Introduction to combustion chamber design, Types of combustion chambers	08

3	**Compression Ignition Engines** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzles, Electronically controlled CRDI system **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	08
4	**Engine lubrication:** Types of Lubricants, their properties, SAE rating of Lubricants, Types of Lubrication systems. **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Limitations, Methods and Types, Different arrangements of Turbochargers. Latest Trends in power boosting methods.	06
5	**Engine Testing and Performance:** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristics of SI and CI Engines, Effects of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric Efficiencies, Heat Balance Sheet. **Engine Exhaust Emission and its control:** Constituents of exhaust emission and its harmful effects on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	08
6	**I C Engine Fuels:** Gasoline - Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas - Biodiesel- Biogas - Producer Gas: Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control Module (ECM): Components, requirement & working. Sensors: Throttle Position, Crankshaft Position, Camshaft Position, Inlet Air Temperature, Coolant Temperature, Mass Air flow and Exhaust Gas Oxygen sensors (their construction and importance in ECM) Electronic Spark control, Air Management system, Idle speed control	05

Text Books:

1. A Course in Internal Combustion Engine, Mathur and Sharma, Dhanpat Rai & Sons, New Delhi, 2001

2. Internal Combustion Engine, V Ganesan, McGraw-Hill, 1995
3. Internal Combustion Engines, Domkundwar & Domkundwar, Dhanpat Rai & Co., 2013

Reference Books:

1. Internal Combustion Engines Fundamentals, Heywood, McGraw Hill, 1988
2. High Speed Combustion Engines, Heldt, Oxford IBH Publishing Co., Calcutta, 1985
3. Internal Combustion Engines, V.L. Maleeve, McGraw-Hill Inc.,US; International 2 Revised ed edition, 1964
4. Fundamental of Internal Combustion Engines, Gill and Smith, 4/E,. Oxford & IBH Publishing Company Pvt. Limited, 2007
5. Fundamentals of Internal Combustion Engines, Gupta, Prentice-Hall of India Pvt.Ltd (June 1, 2006) 2nd ed,
6. Internal Combustion Engine, S.L. Beohar

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approx.40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions to be solved.**

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/103/112103262/
2. https://nptel.ac.in/courses/112/104/112104033/
3. https://onlinecourses.nptel.ac.in/noc20_me42/preview
4. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-me42/

Course Code	Course Name	Credits
AEC503	**Machine Design**	**03**

Objectives:

1. To study basic principles of machine design
2. To acquaint with the concepts of design based on strength & rigidity

3. To familiarize with the use of design data books & various codes of practice
4. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations
2. Illustrate basic principles of machine design
3. Design machine elements for static as well as dynamic loading
4. Design machine elements based on strength/ rigidity concepts
5. Use design data books in designing various components
6. Acquire skill in preparing production drawings of various designs

Module	Details	Hrs
1	**Introduction** Mechanical Engineering Design, Design methods; Material properties and their uses in design; Different considerations in design: Design consideration of casting, forging, Manufacturing, Aesthetic & Ergonomics; Basic principle of Machine Design; Modes of failures; Theories of failures; Different Standards & Codes and Preferred Series and Numbers.	05
2	**Design against static loads** Cotter joint (Socket & Spigot type); Knuckle joint; Turnbuckle; Eccentrically loaded Bolted Joints (considering initial tightening); Eccentrically loaded Welded joints; Power Screw – screw presses, C-clamps along with the Frame.	10
3	**Design of Shaft** Including power transmission and power distribution shafts, under static & fatigue criteria and using ASME code. **Keys** Types of Keys and their selection based on shafting condition **Couplings** Classification of coupling; Design of Flange couplings and Bush pin type flexible couplings.	10
4	**Design of Gears** Design of Spur & Helical Gears: Selection of Material; Gear Blank Design; Number of Teeth; Face Width; Beam Strength of Gear Tooth; Permissible Bending Stress; Effective Load on Gear Tooth; Estimation of Module Based on Beam Strength and Wear Strength.	06
5	**Design against fluctuating loads** Fluctuating, reversed and repeated stresses; Fatigue failure: static and fatigue stress concentration factors; Endurance limit- estimation of endurance limit; Design for finite and infinite life: using Soderberg, Gerber and Goodman design criteria.	06
6	**Design of Springs** Helical compression spring under Static and Variable loads; Design of Leaf springs	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and the second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

The weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. The question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover the maximum contents of the curriculum**
3. **The remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text Books:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohit. Prentice Hall India Publication
3. Machine Design by Pandya & Shah, Charotar Publishing

References:

1. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
2. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
3. Machine Design by Reshetov, Mir Publication
4. Machine Design by Black Adams, McGraw Hill
5. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
6. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
7. Design of Machine Elements by V.M.Faires
8. Design of Machine Elements by Spotts
9. Recommended Data Books – PSG and Mahadevan & Reddy

Links for online NPTEL/SWAYAM courses:

1. Design of Machine Elements | NPTEL Online Videos, Courses - IIT Video Lectures (nptelvideos.in)

Course Code	Course Name	Credits
AEC504	**Finite Element Analysis**	**03**

Prerequisite:

Knowledge of:

- Differential equations (Formulation and solution, Types-Ordinary, Partial, Order and degree of the DE and the boundary conditions)
- Matrix algebra (Matrix operations, gauss elimination method to get inverse the inverse of matrix)
- Basics of the core field (Governing laws, relationship between the various variables and constants –like in structural field stress-strain,Thermal field-temp, heat transfer rate etc

Objectives:

1. To understand the concepts of FEA and its applicability to different engineering field problems.
2. To understand the representation of the physical model into an equivalent FEA model and steps to solve it.
3. To acquaint with application of numerical techniques for solving problems.

Outcomes: Learner will be able to…

1. Solve differential equations using weighted residual methods.
2. Develop the finite element equations to model engineering problems governed by second order differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system.
6. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Details	Hrs
1	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions-types-essential/natural etc. 1.3Approximate solution of differential equations, Weighted residual techniques (Galerkin , Subdomain method).	**5**
2	**FEA Procedure:(Pre-processing, Processing, Post-processing)** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', assembly concepts to develop system equation.	**8**
3	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors. 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams	**10**
4	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element. 4.3 Convergence criterion, sources of errors	**5**

5	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axi-symmetric problems 5.2 Jacobian matrix, stress analysis of CST.	**6**
6	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices. 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams.	**5**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3Only **Four questions need to be solved**

Text/Reference Books:

1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by J N Reddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John- Wiley Sons
7. The Finite Element Method in Engineering by S. S. Rao, Butter Worth Heinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/104/112104193/
https://nptel.ac.in/courses/105/106/105106051/
https://nptel.ac.in/courses/112/104/112104115/
https://nptel.ac.in/courses/112/103/112103295/
https://nptel.ac.in/courses/112/106/112106135/
https://nptel.ac.in/courses/112/106/112106130/
https://nptel.ac.in/courses/105/105/105105041/

https://nptel.ac.in/courses/112/104/112104116/

Course Code	Course Name	Credits
AEDLO5011	**Optimization Techniques**	**03**

Objectives:

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent tools in optimization

Outcomes: Learner will be able to…

1. Identify the types of optimization problems and apply the calculus method to single variable problems.
2. Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.

6. Apply Design of Experiments method for Optimization

Module	Details	Hrs
1	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems. Classical Optimization Techniques: Single variable optimization	**6**
2	Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP Transportation and Assignment Models.	**8**
3	Integer Programming Model: Gomory's cutting plane method, Branch & Bound Technique. Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton's method. Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.	**8**
4	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming. Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness **(Only concepts)**	**8**
5	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method TOPSIS Method PROMETHEE	**6**
6	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design Application of related software (Minitab, Design Expert or MATLAB)	**8**

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. Pablo Pedregal, "Introduction to Optimization", Springer
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. R V Rao, "Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making" (Springer Publication).
7. Ritter, H., Martinetz, T., &Schulten, K., Addison,"Neural Computation and Self-Organizing Maps"-Wesley Publishing Company
8. Douglas C.Montgomery,"Design and analysis of experiments"(John Wiley & Sons Inc.)
9. Saravanan R,"Manufacturing Optimization through Intelligent Techniques", Taylor & Francis (CRC Press)-2006.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/101/112101298/ - Optimization from Fundamentals, IIT Bombay

Course Code	Course Name	Credits
AEDLO5012	**Statistical Techniques**	**03**

Objectives:

1. To acquaint the learners with the basic concepts of Statistical Techniques.
2. To develop understanding of sampling theory.
3. To study methods for curve fitting and regression.
4. To learn statistical decision theory.

Outcomes: Upon successful completion of this course, Learner will be able to…

1. Apply the concepts of statistical distributions in engineering applications
2. Use sampling theory for a given data set
3. Fit curve for a given data set
4. Demonstrate the understanding of correlation and regression analysis
5. Perform analysis of variance from the available experimental data.
6. Demonstrate the understanding of Statistical Decision making and Hypothesis testing

Module	**Content**	**Contact Hours**
1	**Statistical Distributions:** Random Variable and Probability Distribution. Binomial, Poisson, Normal, Exponential, Hypergeometric, Uniform distributions	05
2	**Sampling Theory:** Meaning and Objectives of Sampling. Types of Sampling, Methods of drawing random samples. Sampling Distributions, Standard Error and Probable Error	06
3	**Curve Fitting and Methods of Least Squares:** Relationship between Variables, Curve Fitting, Equations of Approximating Curves, The Method of Least Squares, The Least Squares Line, Non-linear relationships, The Least Squares Parabola.	06
4.	**Correlation and Regression:**	

	Types of Correlation. Linear Correlation, Measures of Correlation, Standard Error of Estimate, Karl Pearson's and Rank Correlation coefficient. Simple linear regression: Least Squares Method.	06
5	**Analysis of Variance (ANOVA):** The Purpose of Analysis of Variance, One-Way Classification, Total Variation, Variation Within Treatments and Variation Between Treatments. The F Test for the Null Hypothesis of Equal Means, Two-Way Classification, Analysis of Variance for Two-Factor Experiments	08
6	**Statistical Decision Theory:** Statistical Decisions, Statistical Hypotheses, Tests of Hypotheses and Significance, or Decision Rules, Type I and Type II Errors, Level of Significance, Tests Involving Normal Distributions, Two-tailed and One-tailed Tests, Special Tests. Confidence Interval, Z test and Chi Square Test for Goodness of fit.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. T Veerarajan, “Probability - Statistics and Random Processes”, McGraw Hill Education
2. Murray R. Spiegel, “Probability and Statistics”, Schaum’s Outline Series, McGraw-Hill Book Company
3. Kothari, C.R.,1985, “Research Methodology-Methods and Techniques”, Wiley Publications
4. N. G. Das, “Statistical Methods”, Vol – I & II, Tata McGraw Hill.

NPTEL

1. Statistical Methods for Scientists and Engineers, IIT Kharagpur (Prof. Somesh Kumar) https://archive.nptel.ac.in/courses/111/105/111105077/
2. Probability and Statistics, IIT Kharagpur (Prof. Somesh Kumar) - https://onlinecourses.nptel.ac.in/noc21_ma74/preview
3. Statistical Inference, IIT Delhi (Prof. Niladri Chatterjee) - https://onlinecourses.nptel.ac.in/noc20_ma19/preview

Course Code	Course Name	Credits
AEDLO5013	**Computational Methods**	**03**

Objectives:

1. Introduction to analytical and numerical techniques.
2. Application of mathematical modelling to mechanical systems.
3. Learn the significance of statistical techniques and data interpolation.

Outcomes: Learner will be able to…

1. Understand and develop mathematical models of physical systems.
2. Identify an appropriate mathematical formulation to linear algebraic equations.
3. Build an appropriate mathematical formulation to non-linear algebraic equations.
4. Evaluate and interpret the data regression, curve fitting and statistics.
5. Apply the numerical techniques and numerical schemes.
6. Formulate the concept of numerical methods in realistic applications.

Module	Details	Hrs
1	**Introduction to Computational Methods** Motivation and applications of Computational Methods. Computation and Error Analysis:Accuracy and precision; Truncation andround-off errors (Numericals); Binary Number System; Error propagation.	**6**
2	**Linear Systems and Equations** Matrix representation: Cramer's rule; Gauss Elimination. Matrix Inversion: LUDecomposition; Iterative Methods;Relaxation Methods; Eigen Values and Eigen Vectors.	**6**
3	**Non Linear Algebraic Equations:** Bracketing methods: Bisection, Regula-Falsi. Crouts Method: LU Decomposition. Open methods: Secant, Fixed pointiteration, Newton-Raphson; MultivariateNewton’s method.	**6**
4	**Regression and Curve Fitting** Interpolation function; Cubic Splines; Multi regression analysis, polynomial regression. **Statistical methods:** Statistical representation of data, modeling and analysis of data, test of hypotheses. **Fuzzy Logic:** Introduction to fuzzy logic, Fuzzy Logic Systems Architecture, Case study of Mechanical system.	**8**
5	**Integration and Integral Equations** Newton Cotes Quadrature **ODEs: Initial Value Problems** Euler's methods; Predictor-corrector method (Adam’s Moulton, Milne’s Method) **ODEs: Boundary Value Problems** Finite difference Method; Finite Element Method, Finite Volume Method	**7**
6	**Application of Numerical Methods** Predict vibration response of components to intricate profile generated by different machine tools, Design next generation Formula One cars to working at the cutting edge of robotics, Predict behaviour of flows to estimation of heat transfer in complex scenarios; Crank Nicolson method	**6**

	– Solution of 1-D Wave equation.	

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

Question paper will comprise of total **six questions**, **each carrying 20 marks**
Question 1 will be **compulsory** and should **cover maximum contents of the curriculum**
Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
Only **Four questions need to be solved**.

Text/Reference Books:

1. S. P. Venkateshan& Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books Pvt. Ltd., 1st Edition, (2014) ISBN: 978-0-12-416702-5.
2. Steven C. Chapra& Raymond P.Canale, "Numerical Methods for Engineers", Mc-Graw Hill Education, 8TH Edition, (2020), ISBN: 1260571386
3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001) ISBN: 0-8247-0443-6.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, 2019.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fifth Edition, 2012.
6. Rajesh Kumar Gupta, Numerical Methods – Fundamentals and Applications, Cambridge University Press, First Edition, 2019.
7. Gupta and Santosh K., "Numerical Methods for Engineers", 4th Edition, New Age International Publishers, 2019, ISBN: 9789387788794
8. FerzigerJ.and M. Peric, "Computational Methods for Fluid Dynamics" 3rd Edition, Springer, (2001) ISBN: 9783540420743.
9. Versteeg H., and W. Malalasekra,"An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, PHI(2007) ISBN: 9780131274983.

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/127/106/127106019/ - Numerical Methods for Engineers, IIT Madras
https://nptel.ac.in/courses/111/107/111107105/ - Numerical Methods, IIT Roorkee
https://nptel.ac.in/courses/111/106/111106101/ - Numerical Analysis, IIT Madras
https://nptel.ac.in/courses/111/107/111107107/ - Numerical Methods: Finite Difference Approach, IIT Roorkee

Course Code	Course Name	Credits
AEL501	**Measurement and Engine Testing Lab**	**01**

Objectives:

1. To acquaint with the various methods for measurement of engine performance.
2. To analyse engine emissions.
3. To familiarise with latest developments in engine Technology

Outcomes: Learner will be able to…

1. Overhaul and Assemble engine components.
2. Perform load test/speed test on engine setup.
3. Calculate performance of multi cylinder engine.
4. Analyse engine performance and draw heat balance sheet.
5. Perform exhaust gas analysis.
6. Get acquainted with Calibration of sensors.

Term work:

Term work shall consist of minimum 8 exercises, from the list as per following details:

a) 2 must be actual experiments from Part A. From Part A exercise 1 is compulsory.
b) 4 must be actual experiments from Part B
c) 2 must be actual experiments from Part C

PART A: Dismantle and assemble the following:

1. 2-Stroke/4-Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

PART B: Actual Test experiments:

1. Morse Test on Multi-cylinder S.I. engine
2. Speed Test on Spark Ignition or/and Compression Ignition engine
3. Load Test on Diesel engine.
4. Heat Balance Sheet on S.I. or C.I. engine.
5. Determination of Air fuel ratio and volumetric efficiency of the engine
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines

PART C: Measurement Experiments:

1. Calibration of Tachometers.
2. Study of Pressure, Torque, Temperature, Flow Measurement Sensors in IC engine.
3. System Identification of any one of the sensors.

PART D: Topics for Case study of various models:

I. Variable Valve Timing
II. Twin and Triple Turbo charging
III. Variable Compression Ratio Engine
IV. Electronic MPFI with various modes
V. Single overhead camshaft and double overhead camshaft
VI. Engine Downsizing
VII. Eco-boost Engine
VIII. Turbocharging for S.I. Engine

Term Work:

The distribution of marks for term work shall be as follows:

1.	Laboratory work (8 Exercises):	**15 marks**
2.	Case study:	**05 marks**
3.	Attendance:	**05 marks**

Practical and Oral Examination:

A. Pair of Internal and External Examiner should conduct practical/Oral exam.

B. Distribution of marks for practical and oral examination shall be as follows:

i.	Practical performance	15 marks
ii.	Oral	10 marks

C. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.

D. Student's work along with evaluation report to be preserved till the next exam.

Course Code	Name of the Course	Credit
AEL502	**Machine Design**	**01**

Objectives:

1. To study basic principles of machine design
2. To familiarize with the use of design data books & various codes of practice
3. To identify potential failures associated with a machine component by using DFMEA.

Outcomes: Learner will be able to…

1. Design Knuckle Joint and cotter joint
2. Design shaft under various conditions.
3. Design rigid and flexible flange couplings.
4. Design helical compression spring and leaf spring.
5. Use design data books in designing various components.

6. Report uncertainties associated with potential failure modes inherited from the component design.

Term Work: (Comprises part A, B & C)
A) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer-aided drawing on **A3 size sheets**.

1) Knuckle Joint/cotter joint
2) Rigid/ Flexible flange couplings
3) Leaf springs
4) C-clamps along with the Frame

B) Assignment: Design exercises in the form of design calculations with sketches and/ or drawings on the following machine elements.

1) Bolted and welded joints
2) Combined stresses problem using the theories of failure.
3) Shaft design with/ without the use of ASME Code.
4) Design against fluctuating loads (For finite and infinite life)
5) Design of Gears

C) Case Study: A case study should be given to either individual or a group of two students to report uncertainties associated with potential failure modes inherited from a component design using the DFMEA approach.

The distribution of marks for term work shall be as follows:

- Part A: 10 marks.
- Part B: 05 marks.
- Part C: 05 marks
- Attendance: 05 Marks.

Course Code	Course Name	Credits
AEL503	**Finite Element Analysis**	**01**

Objectives:

1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to…

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

a. List of Experiments: Students should use the commercial software or open source application programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs (Minimum 6) should be included in the Journal.

The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction
7. Any one problem for analysis of Beams.

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.(using approach of refining mesh and or order of the element)

b. **Course Project: (Any one task** out of the following proposed list **)**

A group of not more than four students, shall do

1) Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.
2) Develop the program to verify the results obtained by manual calculations for simple 1D/2D problems using Python, MATLAB programming platform etc.
3) Simulate a problem and validate the results with experimental results (the test rigs from Strength of material /Heat transfer/Dynamics of machine/fluid lab etc may be used for obtaining the experimental results)

The distribution of marks for term work shall be as follows:

Part a:10 marks.
Part b:10 marks.
Attendance: 05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
   a. Practical performance ……**15** marks
   b. Oral………………... **10** marks

Evaluation of practical examination to be done based on the experiment performed andthe output of the experiments during practical examination.

Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books:

1. Programming the Finite Element Method, I M Smith,D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik,Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by PaletiSrinivas,Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.
6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

Course Code	Course Name	Credits
AESBL501	**Professional Communication and Ethics - II**	**02**

Objectives:
Learners should be able to:

1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitudes and skills.
6. Understand the importance of integrity and develop a personal code of ethics.

Outcomes: Learners will be able to…

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.

6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

MODULE	DETAILS	HRS
MODULE 1 - ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)		
1.1. Purpose and Classification of Reports	**Classification on the basis of:** ● Subject Matter (Technology, Accounting, Finance, Marketing, etc.) ● Time Interval (Periodic, One-time, Special) ● Function (Informational, Analytical, etc.) ● Physical Factors (Memorandum, Letter, Short & Long)	**06**
1.2. Parts of a Long Formal Report	● Prefatory Parts (Front Matter) ● Report Proper (Main Body) ● Appended Parts (Back Matter)	
1.3. Language and Style of Reports	● Tense, Person & Voice of Reports ● Numbering Style of Chapters, Sections, Figures, Tables and Equations ● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
1.4. Definition, Purpose & Types of Proposals	● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
1.5. Parts of a Proposal	● Elements ● Scope and Limitations ● Conclusion	
1.6. Technical Paper Writing	● Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) ● Language and Formatting ● Referencing in IEEE Format	
MODULE 2 - EMPLOYMENT SKILLS		
2.1. Cover Letter & Resume	● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional &	**06**

	Combination)	
2.2 Statement of Purpose	● Importance of SOP ● Tips for Writing an Effective SOP	
2.3 Verbal Aptitude Test	● Modelled on CAT, GRE, GMAT exams	
2.4. Group Discussions	● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	
2.5. Personal Interviews	● Planning and Preparation ● Types of Questions ● Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) ● Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
MODULE 3 - BUSINESS MEETINGS		
3.1. Conducting Business Meetings	● Types of Meetings ● Roles and Responsibilities of Chairperson, Secretary and Members ● Meeting Etiquette	**02**
3.2. Documentation	● Notice ● Agenda ● Minutes	
MODULE 4 -TECHNICAL/ BUSINESS PRESENTATIONS		
4.1. Effective Presentation Strategies	• Defining Purpose • Analysing Audience, Location and Event ● Gathering, Selecting &Arranging Material ● Structuring a Presentation ● Making Effective Slides ● Types of Presentations Aids ● Closing a Presentation ● Platform Skills	**02**
4.2 Group Presentations	● Sharing Responsibility in a Team ● Building the contents and visuals together ● Transition Phases	

MODULE 5 - INTERPERSONAL SKILLS		
5.1. Interpersonal Skills	● Emotional Intelligence ● Leadership & Motivation ● Conflict Management & Negotiation ● Time Management ● Assertiveness ● Decision Making	**08**
5.2 Start-up Skills	● Financial Literacy ● Risk Assessment ● Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
MODULE 6 - CORPORATE ETHICS		
6.1. Intellectual Property Rights	● Copyrights ● Trademarks ● Patents ● Industrial Designs ● Geographical Indications ● Integrated Circuits ● Trade Secrets (Undisclosed Information)	**02**
6.2. Case Studies	● Cases related to Business/ Corporate Ethics	

List of Assignments for Termwork

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
7. IPR
8. Interpersonal Skills
9. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Guidelines for Internal Assessment

Term Work	25 Marks
Assignments	10 Marks

Attendance	05 Marks
Presentation slides	05 Marks
Book Report (hard copy)	05 Marks
Internal Oral -	25 Marks

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	10 Marks
Project presentation (Individual Presentation)	10 Marks
Group Dynamics	05 Marks

SUGGESTED READING

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational Behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Virtual Labs

https://ve-iitg.vlabs.ac.in/- Virtual English and Communication Virtual Lab, IIT Guwahati

http://vlabs.iitb.ac.in/vlabs-dev/labs/communication/- Professional Communication Virtual Lab, IIT Bombay

Course code	Course Name	Credits
AEPBL501	**Mini Project - 2A**	**02**

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the

Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on log book	: 10
Marks awarded by review committee	: 10
Quality of Project report	: 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact

7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Credits
AEC 601	**Automotive Systems & Design**	**04**

Objectives:

1. To study the basics of automotive systems and subsystems.
2. To study working of different automotive systems and subsystems.
3. To study different types of vehicle layout.
4. To have a basic idea about how automotive systems are designed.

Outcomes: Learner will be able to…

1. Identify different Automotive systems and components.
2. Compare different types of Automotive systems and components.
3. Understand the working of different types of Automotive systems and components
4. Apply knowledge of Engineering Mechanics and Strength of materials to design different Automotive systems and components.
5. Select materials for different Automotive systems and components for designing.
6. Design the different Automotive systems and components by using a data book.

Module	Details	Hours
1.	**Frame-**Different types of Layouts **Design of Engine Components-**Types of Piston and Cylinder Liners,Types of Connecting Rod(Only Barrel Type) and Types of Crankshaft(Only Centered type)	**08**
2.	**Automotive Clutches and Transmission-** Necessity of clutch in a automobile, Working and Construction of Single plate,Multi-plate,Centrifugal,Semi Centrifugal, Electromagnetic clutches, Fluid Flywheel,Torque Converter Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Wear and thermal consideration. **Epicyclic Gearboxes used in automatic transmissions-** Principle of Planetary gear trains, Continuously Variable Transmission-Types and Operation of typical CVT **Design of Gearbox-**Constant Mesh	**12**
3.	**Drive Line**: UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.Driving thrust and its effects, Torque reaction and Side thrust, Hotchkiss drive, Torque tube drive, Radius rods, Stabilizers **Final Drive** –Types of Final drive,Loads acting on Front and Rear axles,Types of Front Axles and Stub axles. **Differential** –Principle, Constructional details of Differential unit,Housing,Non slip differential and differential locks types- **Design of Drive Line-**Design of propeller shaft and Axles	**08**

4.	**Steering**-Introduction to steering systems, Manual Steering, Ackerman and Davis Steering Mechanisms, Steering Linkages Different types of Steering gear boxes,Power steering systems, Front End Wheel Geometry.	**04**
5.	**Brakes-** Introduction to Brake System, Components of Brake System,Mechanical Brakes, Hydraulic Brake, Air Brake, Anti Lock Brake System, Braking Analysis,Materials for Brake Lining. **Design of Brakes-**Stopping Distance,Energy Absorbed by a Brake, Heat to be dissipated during Braking.	**08**
6.	**Suspension-** Introduction to Suspension System, Components of Suspension System, Dependent and Independent Suspension and Types,Types of Suspension Springs-Single leaf, Multi Leaf spring, Coil, Torsion Bar, Rubber, Pneumatic and Hydro elastic suspension spring systems. **Wheels and Tyres-** Tire requirement, tire characteristics, Constructional detail, tire dimensions and specifications, Types of wheels and Hubs.	**08**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks

2. Question 1 will be compulsory and should cover maximum contents of the curriculum covered in Theory and Laboratory.

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) covering contents of the curriculum covered in Theory and Laboratory.

4. Only Four questions need to be solved.

Text Books:

1. Newton, Steed & Garrett, Motor Vehicles, Butterworth Heinemann.

2. N. K. Giri, Automotive Mechanics, Khanna Publishers.

3. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.

4. Design of machine elements - V. B. Bhandari Tata McGraw Hill Pub.

5. Recommended Data Books – PSG , K. Mahadevan,Kale Khandare

6. Gear Design Handbook - GitinMaitra

Reference Books:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.

2. Jack Erjavec, Automotive Technology – A systems approach, Cengage Learning.

3. M. J. Nunny, Automotive Technology, SAE Publication.

NOTE:

Use of standard design data books like PSG Data Book, Design Data by Mahadevan, and Design data by Kale Khandhare is permitted at the examination and shall be supplied by the institute.

Links for Online NPTEL/SWAYAM Courses:

1.https://onlinecourses.nptel.ac.in/noc20_me18/preview

2.https://nptel.ac.in/courses/112/105/112105124/

3.https://nptel.ac.in/courses/112/105/112105219/

Course Code	Course Name	Credits
AEC602	**Mechanical Vibrations**	**03**

Objectives:

1. To study the basic concepts of vibration analysis.

2. To estimate the natural frequency/frequencies of vibration systems in free vibration, using both exact and numerical methods.

3. To estimate the response of 1 degree of freedom under forced vibration.

4. To acquaint with the basic principles of vibration measuring instruments.

5. To study the balancing of rotating and reciprocating mass systems.

Outcomes: Learner will be able to...

1. Develop mathematical models to represent dynamic system.

2. Estimate natural frequency of mechanical system using various methods.

3. Analyze vibratory response of mechanical system under forced vibration.

4. To estimate the natural frequencies and mode shapes of multi-degree of freedom system, using both exact and numerical methods.

5. Balance an existing unbalanced system partially/completely.

Module	Details	Hours
01	**1.1 Basic Concepts of Vibrations:** Vibration and oscillation, causes and effects of vibrations, vibration parameters—spring, mass and damper, minimum number of parameters required for vibration to occur, vibration terminology, classification of vibrations, steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration Systems:** Methods to formulate differential equation—Newton's method or D'Alembert's principle, and Energy methods—Based on conservation of total energy, Rayleigh's energy method, Lagrange's energy method, equivalent system method. Springs in series and parallel combination, inclined spring, effect of spring's own mass to calculate natural frequency of system. Application of these methods in longitudinal, transverse and torsional single degree of freedom vibration systems, or a combination of these.	**07**
02	**2.1 Free Damped Single Degree of Freedom Vibration Systems:** Need of damping in vibration systems, introduction to damper models—viscous, Coulomb (dry friction), slip/interfacial, solid/structural/hysteresis damping (Note: only basic introduction to slip and solid dampings, no calculations expected). Viscous damping—Derivation of differential equation of motion, derivation of solution (response) equations, damping ratio or damping factor, critical damping coefficient, underdamped, critically damped and over damped systems. Logarithmic decrement, Work done by viscous damper, inclined damper, dampers in series and parallel combinations. Coulomb/dry-friction damping—derivation of differential equation, number of cycles covered by the mass to stop once disturbed (disturbance in the form of initial displacement only), comparison of viscous and Coulomb dampings.	**08**
03	**3.1 Free Undamped Multi Degree of Freedom Vibration Systems:** Exact methods for derivation of differential equations of motion for multi degree of freedom systems—Newton method and Lagrangian energy method, matrix analysis to estimate eigenvalues and eigenvectors & hence natural frequencies and mode	

	shapes for multi-mass undamped vibration systems (limited to 2 degree of freedom only), Holzer’s method for longitudinal and torsional unbranched vibration systems, Dunkerley’s and Rayleigh’s methods for estimating fundamental frequency of tranverse vibration of simply supported and cantilever beams (up to a maximum of 4 point loads only), influence coefficients and Maxwell’s reciprocal theorem.	**07**
04	**4.1 Forced Single Degree of Freedom Vibration Systems:** Analysis of linear and torsional systems subjected to harmonic excitation in terms of force and motion (viscous damping only), force isolation and transmissibility, isolators and mounts. **4.2 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer, velometer—with and without measurement errors. Principle of frequency-measuring instruments, Fullarton’s tachometer and Frahm’s reed tachometer.	**07**
05	**5.1 Balancing of Rotating Masses:** Static and dynamic balancing of multi-rotor system. **5.2 Balancing of Reciprocating Masses:** Approximate analytical method for finding acceleration of reciprocating piston (mass of connecting rod and crank neglected), primary and secondary unbalanced forces, inline engine, direct and reverse crank method.	**07**
06	**6.1 Whirling of Shafts / Rotor Dynamics / Critical Speed:** Critical speed of a single rotor—undamped and damped.	**03**

Theory Examination:

Internal Assessment (20 marks):

Consisting of **2 compulsory class tests.**

First test based on initial 40% of the content, and second test based on remaining content (but excluding contents covered in Test-1).

End Semester Examination (80 marks):

Weigtage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

i. Question paper will comprise of total six questions.

ii. All questions carry equal marks.

Iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

iv. Only four questions need to be solved.

Term Work (25 marks):

This shall consist of a file submission that includes **laboratory work (10 marks)**, **assignments (10 marks),** and **attendance in theory and practicals (rounded off to 5 marks)**.

Viva -voce (Orals) and Practical Examination (25 marks):

Viva-voce (Orals) and Practical Examination shall be conducted in the presence of one Internal Examiner (from parent college) and one External Examiner (from other college/industy expert), and marks should be allotted as per the following scheme:

(i) Viva-voce (Orals): 10 marks

(ii) Practical : 15 marks

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/107/112107212/
2. https://nptel.ac.in/courses/112/103/112103112/
3. https://nptel.ac.in/courses/112/103/112103111/
4. https://nptel.ac.in/courses/112/107/112107087/

Text/Reference Books:

1. Mechanical Vibrations 4th ed- S. S. Rao - Pearson Education
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibration - S.Graham Kelly - Tata McGraw Hill 4.
4. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- McGraw Hill
6. Mechanical Vibrations - Schaum's outline series - William W. Seto- McGrmvHill .Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - New Age International Publications.
7. Mechanical Vibrations - Den; Chambil, Hinckle
8. Mechanical Vibrations, J.P. Den Hartog, McGrawhill Book Company Inc.
9. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. Wiley, New York,
10. Leonard Meirovitch, Elements of Vibration Analysis. McGrmv-Hill, New York,
11. Leonard Meirovitch, Dynamics and Control of Structures. Wiley, New York. 4. Antony J. Pettofrezzo,
12. Matrices and Transformations. Dover, New York.
13. Benson H. Tongue, Principles of Vibration. Oxford University Press.
14. W. Thomson, Theory of Vibrations with Applications, Second Edition, Pearson Education
15. Vibrations-BalakumarBalachandan, Edward Magrab, CENGAGAE Learning.

Course Code	Course Name	Credits
AEC603	**Vehicle Body Engineering and Safety**	**03**

Objectives:

1. To Understand fundamentals of Vehicle Body design.
2. To Study different vehicle structural design and their requirements.
3. To Study various static and dynamics load acting on the vehicle.
4. To familiarize with basic concepts of vehicle safety.
5. To study safety features and safety regulations.

Outcomes: Learner will be able to…

1. Illustrate different types of Vehicle structures.
2. Comprehend various loads acting on vehicle body.
3. Classify different materials related to vehicle body.
4. Discuss Aerodynamic concept related to vehicle body.
5. Comprehend Vehicle design from safety point of view.
6. Enumerate interrelation ship among occupant, restraint systems and vehicles in accidents.

Module	Details	Hrs.
01	**1.1 Vehicle Chassis:** Introduction, functions and design considerations, Chassis frame components, Sections used, types of frames. Location of different chassis components, exterior and interior trims, Location of power plant. structure types: Open, Semi integral and Integral bus structure **1.2 Vehicle Body:** Introduction, Classification of vehicle based on body types, Requirements of body, Loads on the vehicle body. **1.3 Vehicle body materials** Introduction to materials used in vehicle body building (Steel sheet, timber, plastics, aluminium alloy, glass, Ultralight Steel Auto Body (ULSAB), FRP, GRP etc., properties of materials-Corrosion anticorrosion methods, selection of paint and	**08**

	painting process)	
02	**2.1 Visibility:** Regulations, driver’s visibility, Methods of improving visibility. Bus Floor height, engine location, entrance and exit location, seating dimensions. Driver cabin design. **2.2 Structural surface:** Terminology and overview of structural surface types, Vehicle structure analysis by simple structural surface (SSS) Method. Thin Walled Structures-General Principle, Torsion, Torsion centre, Forces in End Load Carrying Members. **2.3 Overall Criteria for Vehicle Comparison:** Design, Running costs, Overall Design Efficiency. **2.4 Aerodynamics:** Objectives, Various types of forces and moments, body optimization techniques for minimum drag.	**08**
03	**3.1 Preliminary design:** Drawing of the preliminary design, Vehicle Body Weight Analysis, Calculation of C.G for Vehicle, Master Model. **3.2 Body Loads:** Bending, Torsion, Lateral and Braking and Acceleration Load Cases. Idealized structure, Structural surface, Shear panel method, Symmetric and asymmetric vertical loads in a car, Longitudinal load, Different loading situations.	**07**
04	**4.1 Vehicle safety** : Introduction, energy equation, types of vehicle collision, Types of safety (Active and Passive). **4.2 Basic concepts of vehicle safety** Fail-safe, Alternative design, Redundancy and derating, Fault tolerance, Universal design. **4.3 Design of seat:** Design and requirement of Driver, Passenger and child seat**,** Occupant Protection,	**07**

	Biomechanics and Occupant Simulation. Role of seat and seat belt in vehicle crash.	
05	**5.1 Crash Testing:** Introduction, Crash testing methods, vehicle body testing, Dynamic Vehicle Simulation, Pedestrian Protection. **5.2 Body repair techniques:** Introduction, tools, repairs procedure.	**06**
06	**6.1 Passive Safety Features** Air bags, Crumple zone, bumper design for safety. **6.2 Active Safety Features** Anti-lock braking system, Electronic Stability Control (ESP), Collision warning system, adaptive cruise control. **6.3 Overview of Vehicle Scrapping Policy in India, Scrapping Methodology.** **6.4 Introduction to automotive standards (AIS, FMVSS, CMVR/CMVSS).**	**05**

Theory Examinations:
Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.
i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

Text/Reference Books:

1. John Fenton, “Vehicle Body Layout & Analysis”, Hutchinson, London.
2. J Powloski, “Vehicle Body Engineering”, Business Books Ltd., London.
3. J.G. Giles, “Body Construction and Design”, Vol. 6. llefe Books/Butterworth & Co. London

4. P. L. Kohli, “Automotive Chassis & Body”, Papyrus Publishing House, New Delhi.
5. John Fenton, “Handbook of Automotive Body Construction and Design Analysis” Professional Engineering Publishing.
6. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
7. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
8. Automotive Safety Handbook by Ulrich W. Seiffert and LotharWech, SAE International, 2007.
9. Public Safety Standards of the Republic of India

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/107/103/107103084/
2. https://nptel.ac.in/courses/107/106/107106080/

Course Code	Course Name	Credits
AEC604	**Automation and Artificial Intelligence**	**03**

Objectives:

1. To understand the need and justification of automation.
2. To study design of pneumatic and hydraulic circuits.
3. To study and understand electropneumatic circuits and PLC Design
4. To familiarize with robotic systems in automated manufacturing processes.
5. To study and understand AI and machine learning technologies for automation.

Outcomes: Learner will be able to…

1. Demonstrate understanding of fundamentals of industrial automation and AI.
2. Design & develop pneumatic / hydraulic circuits.
3. Design and develop electropneumatic circuits and PLC ladder logics.
4. Demonstrate understanding of robotic control systems and their applications.
5. Demonstrate understanding of various AI and machine learning technologies.
6.

Module	Details	Hrs
1	**1.1 Introduction to Automation** Definition and fundamentals of automation, Elements of Automated system, Automation principles and strategies, Levels of automation, types of automation, Advanced automation functions **1.2 Introduction to Artificial Intelligence** Introduction, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Mechanical Engineering	**04**
2	**2.1 Design of Pneumatic Circuits** Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 2 cylinders) **2.2 Design of Hydraulic Circuits** Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit	**08**

	and sequencing circuits.	
3	**3.1 Electro-pneumatic Circuits** Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; **3.2 PLC Discrete Control Systems** Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.	**08**
4	**Robots and their applications**: Introduction to Robots, Types, Classifications, Selection of Robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a Robot, Robot feedback controls: Point to point control and Continuous path control, Control system for Robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications, Nex-gen robots.	**07**
5	**(Concept and Algorithms, No programming or numericals)** **5.1 Problem Solving:** Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound **5.2 Machine Learning:** Introduction, types of machine learning: supervised, unsupervised, reinforcement learning **5.3 Learning with Decision Trees:** Introduction to Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbours algorithm, hierarchical clustering, Concept of ensemble methods: bagging, boosting, random forests	**06**
6	**(Concept and Algorithms, No programming or numericals)** **6.1 Learning with regression:** Linear regression, Logistic regression **6.2 Artificial Neural Networks** Concept of ANN, Basic Models of Artificial Neural Networks Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, backpropagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions **6.3 Introduction to AI Technologies in the realm of Automation** Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
4. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Industrial Hydraulics: Pippenger
9. Vickers Manual on Hydraulics
10. Hydraulic Valves and Controls: Pippenger
11. Fundamentals of pneumatics: Festo series
12. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
13. Mechatronics, HMT
14. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education,New Delhi
15. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
16. Yoram Korean, "Robotics for engineers", McGrew Hill Co
17. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
18. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
19. Artificial Intelligence: A Modern Approach by Peter and Norvig ISBN-0-13103805-2,
20. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0-07008770-5, TMH,
21. Artificial Intelligence by Saroj KausikISBN:- 978-81-315-1099-5, Cengage Learning
22. Artificial Intelligence and Intelligent Systems by Padhy, Oxforfd University Press,
23. Artificial Intelligence & Machine Learning by Vinod Chandra .S.S. Anand Harindran. S. (PHI)
24. A first course in Artificial Intelligence – By Deepak Khemani. Mc GrawHill

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/103/112103174/
https://nptel.ac.in/courses/112/103/112103293/
https://nptel.ac.in/courses/112/102/112102011/
https://nptel.ac.in/courses/112/101/112101098/
https://nptel.ac.in/courses/112/103/112103280/
https://nptel.ac.in/courses/106/106/106106139/

Course Code	Course Name	Credit
AEDLO6021	**Press Tool Design**	**03**

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to…

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. understand safety aspects and automation in press working

Module	Details	Hrs
1	**Introduction to Press Working** 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Press working terminology, Functions of different elements of a press tool. material handling equipment, Methods of feeding the strip/coil material.	**06**
2	**Design Progressive die** 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, recommending minimum tonnage of a press, Methods of reducing cutting loads on press tools 2.2 Design aspects of Press tool elements viz. Punches & methods of mounting punches, types of Die block, Stripper, Pilot, stock guides, stock stops, Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools. 2.3 Centre of pressure, Different types Die sets and its selection, shut height of die, Problems based design of progressive die	**10**
3	**Bending and Drawing-** 3.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies, roller bending, bending force problems on bend length calculation and bending force, 3.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup, problems on drawing 3.3 Defects in drawn parts 3.4 Basic construction and working of Bending and Drawing dies	**08**
4	**Miscellaneous Dies-**	**04**

	Basic construction & working of Shaving dies, Trimming dies, Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies, drop through and inverted die, curling die, transfer die	
5	**Selection of Presses and its setting** Classification of presses, Selection of Press and Press setting, calculation of shut press shut height and die shut height, Overloading of presses (load, energy considerations)	**04**
6	**Introduction to Automation & Safety in Press shop** Types of CNC Press, Types of CNC press controller, Basic hydraulic and pneumatic circuit used in press for stock feeding and ram movement, different types sensors used for hand protection, stock feeding etc., other safety equipment like break, clutch, face shield etc.	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books:

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credit
AEDLO6022	**Tool Engineering**	**03**

Objectives:

1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life, surface roughness and tool materials.
2. To familiarize with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to…

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyze heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyze economics of machining operations

Module	Details	Hrs
1	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model & modified model for orthogonal cutting, problems on above topic. 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gauge lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, piezoelectric dynamometry	**08**
2	2.1 **Temperatures in metal cutting and cutting fluids**: Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work tool thermocouple, direct thermocouple measurement, radiation methods, hardness changes in steel tools, Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, dry cutting and minimum quantity lubrication, cryogenic cooling, cutting fluid maintenance and environmental considerations, disposal of cutting fluids	**05**
3	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools, Techniques for manufacturing coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	**04**
4	**Tool life and Machining Economics**: 4.1 Definition, tool wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, machinability of material, factors affecting machinability, 4.2 Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate, problems on above	**06**

	topic.	
5	**Design of single point cutting tools**: Different systems of tool nomenclature like MRS and ORS, Constructional features of solid tool, tipped tools, mechanically held regrindable insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders, Tool design for EDM and USM.	**05**
6	**Design of multi point cutting tools**: Introduction to various form tools, Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters, Drill, Reamer and Tap design using standard procedure.	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow
8. Production Technology – HMT handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credits
AEDLO6023	**Metal FormingTechnology**	**03**

Objectives:

1. To conversant with the basic knowledge on fundamentals of metal formingprocesses
2. To study various metal formingprocesses
3. Understanding plastic deformation and technical analysis of forming processes

Outcomes: Learner will be able to

1. Understand the concept of different metal formingprocess.
2. Approach metal forming processes both analytically andnumerically
3. Design metal formingprocesses
4. Develop approaches and solutions to analyze metal forming processes and the associated problems andflaws.

Module	**Details**	**Hrs**

1.	**Introduction to Metal Forming:** Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, effects of temperature, strain rate, microstructure and friction in metal forming-yield criteria and their significance, Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, deformation mechanisms, Hot and Cold Working Processes and Its Effect on MechanicalProperties.	**08**
2.	**Rolling:** Introduction and Classification, Types of Rolling Mills, Forces andGeometrical Relationships in Rolling, Calculation of Rolling Load, Roll Pass Design, and Defects in Rolled Products.	**07**
3.	**Forging:** Introduction and Classification, operation and principle of Forging Processes and Equipment, Methods of forging, Open and Close Die Forging Processes, Defects, Structure and Properties of Forged Products. Force Analysis inforging.	**07**
4.	**Extrusion:** Introduction and Classification, Extrusion Equipment, Forces inextrusion, Analysis of Extrusion Process, Extrusion of components including Seamless Pipes and Tubes. Extrusion of pipes by cold working,	**06**
5.	**Drawing:** Introduction and Classification, Wire Drawing, Rod Drawing, Tube Drawing, Deep Drawing, Analysis of Wire Drawing Process and Load Calculations.	**06**
6.	**Sheet Metal Forming:** Principle, process parameters, equipment and application of the following processes: spinning, stretch forming, plate, V and edge bending, Curling, Ironing, Roll Bending, Metal Spinning. Press brake forming, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming.High Velocity forming of metals and High energy Rate forming	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4. Only Four questions need to be solved.

Text/Reference Books: -

1. Lin D Balint M Pietrzyk, Microstructure Evolution in Metal Forming Processes 1st Edition
2. Amitabha Ghosh and Asok Kumar Mallick, Manufacturing Science, Affiliated East-West Press
3. Christian Brecher and Ozdemir , Advances in Production Technology, Springer Publications
4. P.C.Sharma , A Text Book on Production Engineering, S.Chand Publications
5. P. N. Rao, “Manufacturing Technology”, Tata McGraw Hill
6. Aviter, “Fundamental of Metal Working”, McGraw Hill Publisher
7. Dieter, “Mechanical Metallurgy”

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/107/112107250/ - Principles of Metal Forming Technology, IIT Roorkee
https://nptel.ac.in/courses/112/106/112106153/ - Forming, IIT Madras

Course Code	Course Name	Credits
AEL601	**Automotive System Design**	**01**

Objectives:

1. To help students better understand Automotive systems and subsystems through Dismantling and assembling of various subsystems components.
2. To give hands on experience to students on designing different automotive components.
3. To Understand and apply concepts in designing automotive components.

Outcomes: Learner will be able to…

1. Identify Automobile systems and subsystems.
2. Dismantle and assemble Clutch and gearbox
3. Dismantle and assemble Propeller shaft
4. Dismantle and assemble Steering Gearbox
5. Dismantle and assemble Differential
6. Demonstrate design calculations for various automotive components.

Term Work :(Comprises both A & B)

A.List of Experiments

1. Dismantling and reassembling of Clutch.

2. Dismantling and reassembling of Gear box.

3. Dismantling and reassembling of Propeller Shaft.

4. Dismantling and reassembling of Differential.

5. Dismantling and reassembling of Steering gear linkages and steering gear box.

6. Dismantling and reassembling of any one type of braking systems.

B.Design Calculations

a.Exercises on the following in the form of design calculations(Any Three)

A. Design of any one Engine Component

B.Design of clutches (Single,Multi and Centrifugal)

C. Design of Gearbox

D. Design of Brakes

E.Design of Propeller Shaft/Axles

The distribution of marks for term work shall be as follows:

1) Part A: 10 marks

2) Part B: 10 marks

3) Attendance (Theory and Practical): 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral based on contents Distribution of marks for practical/Oral examination shall be as follows:

Practical performance:15 marks

Oral: 10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEL602	**Mechanical Vibrations**	**01**

Objectives:

1. Study some single undamped degree of freedom systems theoretically and experimentally, and validate the time period of small vibrations/oscillations.
2. Obtain displacement vs. time graphs experimentally, and plot the same through response equations by the use of graphing and programming software viz., MS Excel etc.
3. Plot dimensionless steady-state amplitude vs. frequency ratio curves for various values of damping ratio for the case of forced vibrations, by the use of some programming software.
4. Balance a rotating system statically and dynamically.
5. Perform virtual experiments using Sakshat Virtual Laboratory.

Outcomes: Learner will be able to…

1. Derive the differential equation of motion, frequency & time-period, for the given single degree of freedom vibration system, for small oscillations.
2. Perform experiments on physical vibration systems and compare the theoretical and experimental results, for validation and verification.
3. Program using scientific mathematical software or using basic programming software, to obtain the necessary plots in time and frequency domains, and interpret the results thus obtained.
4. Balance a rotating unbalanced system completely, by making use of analytical and/or graphical methods.
5. Perform simulation of experiments through Sakshat Virtual Laboratory interface.

List of Experiments: At least 6 experiments based on the **serial numbers 01 – 07** as follows:

Sr. No.	**Title of the Experiment**	**Lab. Sessions (Hours)**

01	Determining the undamped natural frequency / time period of free undamped vibrations/oscillations of the following systems, theoretically and experimentally: (**any 4**) 1. Simple spring-mass system 2. Simple pendulum 3. Compound pendulum 4. Single rotor-shaft system 5. Bifilar suspension system	**08**
02	Free damped torsional oscillations.	**02**
03	Forced vibration of one degree of freedom system, subjected to frequency-squared excitations (rotating unbalance).	**02**
04	Computer program on frequency-domain plots of dimensionless steady-state amplitudes for various values of damping ratio.	**02**
05	Dunkerley's / Rayleigh's experiment on transverse vibration of beam for finding fundamental frequency.	**02**
06	Balancing of rotating masses.	**02**
07	Virtual Laboratory Experiments using Sakshat VLab portal.	**04**

Text/Reference Books:

1. Vibration Monitoring, Testing, and Instrumentation (Mechanical Engineering Series) - Clarence W. deSilva - CRC Press.

2. Vibration Testing: Theory and Practice - Kenneth G. McConnell, Wiley.

3. Modal Testing: A Practitioner's Guide - Peter Avitabile - Wiley.

Course Code	Course Name	Credits
AEL603	**Vehicle Body Engineering and Safety**	**01**

Objectives:

1. To help student understand and model various cross-sections used in chassis frame.
2. To help student to understand different vehicle body styles.
3. To give hands on experience to students on Designing and analysis of Chassis Frame.
4. To study vehicle comparison criteria.

Outcome: Learner will be able to

1. Model various cross sections used in Chassis frame.
2. Calculate various loads acting on chassis frame.
3. Compare to vehicles of same class.
4. Illustrate different vehicle body styles.
5. Compute tractive force and centre of gravity of the vehicle.

Term Work: (Comprises of parts A, B & C)

A. List of Experiments

1. Structural analysis of Chassis Frame using any FEA Software's for different sections (C-section, I- section, L-section, O-section, Hat section, Tubular section).

2. Case study on crash test dummy.

3. Comparison of two vehicles under same class based on overall design criteria and safety features.

4. Case study on tractive force analysis.

5. Case study on Centre of gravity calculation.

6. Case study on automotive standards (AIS, FMVSS, CMVR/CMVSS).

(Perform any four experiments from the list)

B. Mini Project

Analysis of Chassis frame containing a 3D Model of any existing Automobile Chassis or Body or combination of both (Min 2 Max 4 Students per Group)

C. Drawing sheet

Three A2 size sheets based on

1. Car body style
2. Bus body style
3. Commercial Vehicle body style

The distribution of marks for term work shall be as follows:

1) Laboratory work (Experiments) : **05 marks**

2) Mini project : **10 marks**

3) Drawing sheets : **05 marks**

4) Attendance (Theory and Practical) : **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral based on contents

   Distribution of marks for practical/Oral examination shall be as follows:

   Practical performance 15 marks
   Oral 10 marks
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination

Note:- Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AESBL601	**Measurements and Automation**	**02**

Objectives:

1. To study fundamentals of inspection methods and systems.
2. To study working of mechanical measurement system.
3. To familiarise with different types of control systems.
4. To study different hydraulic and pneumatic systems.
5. To study various design principles of robotics through kinematic analysis, workspace analysis and trajectory planning.

Outcomes: Learner will be able to…

1. Apply inspection gauge to check or measure surface parameters.
2. Measure surface parameters using precision measurement tools and equipment.
3. Measure different mechanical parameters by using sensors.
4. Analyse the response of a control systems.
5. Demonstrate use of automated controls using pneumatic and hydraulic systems.
6. Implement program on PLC system and demonstrate its application

The laboratory experiments should be based on the following:

Group A (Metrology):

1. Experiments on linear and angular measurement using Vernier calliper, micrometer and Bevel protractor.
2. Experiments on surface measurement by using Surface roughness tester.
3. Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester.
4. Experiments on screw thread measurement using screw thread micrometer, Floating carriage micrometer / bench micrometer.
5. Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector or Tool maker's microscope.
6. Experiment using Mechanical / Pneumatic type Comparator.
7. Experiments on flatness measurement by Autocollimator / Interferometry method

Group B (Mechanical Measurement):

1. Experiments on measurement of displacement by sensors like LVDT, Potentiometers etc.
2. Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc.
3. Experiments on measurement of vibration by accelerometers or NI.
4. Experiments on feedback control systems and servomechanisms
5. Experiment on frequency response system identification / transient state response of a control system.
6. Experiment on design of PID controller for a system or simulate and tune a PID controller using lab view.

Group C (Automation):

1. Experiment on trainer kit (Any one)

a) Designing sequential operation for two cylinders using electro-hydraulic circuits.

or

b) Designing sequential operation for two cylinders using electro- pneumatic circuits.

2. Experiment on simulation using software like Festo, AutoSim etc.

a) Simulation of basic pneumatic and electro-pneumatic circuits.

or

b) Simulation of hydraulic and electro-hydraulic circuits.

3. Experiments on Ladder programming

a) Experiments on Ladder programming on PLC for simple ON OFF control, timers, counter, two motor system, simple control applications with logic/ timers/counters.

or

b) Experiments on Ladder programming for Mechatronics system (e.g. bottle filling plant, control of electro-pneumatic or electro-hydraulic systems).

4. Experiments on Robotics

a) Demonstration and study of functions of components of robotics arm.

or

b) Visualization of DH (Denavit–Hartenberg) parameters in Roboanalyzer (*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com).

Term Work

Term work shall consist of minimum Nine Experiments. Three from each group mentioned above. There will be no theoretical assignment for the lab course. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	:	20 marks
Attendance:	:	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical and viva based on contents.
2. Practical examination (in a group of not more than 4 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:

Practical performance:	15 marks
Oral:	10 marks

4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.
5. Students work along with evaluation report to be preserved till the next examination.

Virtual Labs

http://ial-coep.vlabs.ac.in/ - Industrial Automation Laboratory, COEP

Course code	Course Name	Credits
AEPBL601	**Mini Project - 2B**	**02**

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

5. Identify problems based on societal /research needs.
6. Apply Knowledge and skill to solve societal problems in a group.
7. Develop interpersonal skills to work as member of a group or leader.
8. Draw the proper inferences from available results through theoretical/ experimental/simulations.
9. Analyse the impact of solutions in societal and environmental context for sustainable development.
10. Use standard norms of engineering practices
11. Excel in written and oral communication.
12. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
13. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the

Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact

7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication