AC-26/2/2015, Item No. 4.61

UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics Engineering

Final Year Engineering

(Sem. VII and VIII), Revised course

(REV- 2012) effective from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

In the process of change in the curriculum there is a limited scope to have major changes in the fundamental subjects which are mainly part of second year of engineering. The exposure to the latest technology and tools used all over the world is given by properly selecting subjects and their hierarchy in pre-final and final year. Thus this syllabus is made to groom the undergraduate students best suited and competent in all respect with best possible efforts put in by the experts in framing detail contents of individual subjects.

The engineering education in India is expanding in manifolds and the main challenge is the quality education. All the stakeholders are very much concerned about it.

The institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation.

So the curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. 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, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, happy to state here that, heads of the department and senior faculty from various institute took timely and valuable initiative to frame Program Educational Objectives as listed below.

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 believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

The subjects offered to undergraduate students in final year are at par to the requirement of industry. The students are also made competent to appear for various competitive examination conducted in India and abroad. The subjects offered are at enough level to prepare a base of the students to understand and learn latest state of technology. The students are trained in such a way that they become versatile in hardware and software simulation. Some subjects offered upgrades them in the field of information and technology which is a need of today's' era.

At the end I must outset extend my gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr. D. G. Borse
Chairman, Board of Studies (Electronics Engineering)

Semester -VII

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC701	Embedded System Design	04	--	--	04	--	--	04
EXC702	IC Technology	04	--	--	04	--	--	04
EXC703	Power Electronics –II	04	--	--	04	--	--	04
EXC704	Computer Communication Networks	04	--	--	04	--	--	04
EXC 705X	Elective - I	04	--	--	04	--	--	04
EXC 706	Project - I					02		02
EXL701	Embedded System Design Laboratory	--	02	--	--	01	--	01
EXL702	IC Technology Laboratory	--	02	--	--	01	--	01
EXL703	Power Electronics –II Laboratory	--	02	--	--	01	--	01
EXL704	Computer Communication Networks Laboratory	--	02	--	--	01	--	01
EXL705X	Elective – I Laboratory	--	02	--	--	01		01
Total		**20**	**10**	**--**	**20**	**07**	**--**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC701	Embedded System Design	20	20	20	80	-	--	--	100
EXC702	IC Technology	20	20	20	80	--	--	--	100
EXC703	Power Electronics –II	20	20	20	80	--	--	--	100
EXC704	Computer Communication Networks	20	20	20	80	--	--	--	100
EXC705X	Elective - I	20	20	20	80	--	--	--	100
EXC706	Project -I					25	--	25	50
EXL701	Embedded System Design Laboratory	--	--	--	--	25	--	25	50
EXL702	IC Technology Laboratory	--	--	--	--	25		25	50
EXL703	Power Electronics –II Laboratory	--	--	--	--	25	--	25	50
EXL704	Computer Communication Networks Laboratory	--	--	--	--	25	--	25	50
EXL705X	Elective – I Laboratory	--	--	--	--	25	--	25	50
Total		**--**	**--**	**100**	**400**	**150**	**00**	**150**	**800**

Elective – I

Code	Name of Elective
EXC7051	Digital Image Processing
EXC7052	Artificial Intelligence
EXC7053	ASIC Verification
EXC7054	Optical Fiber Communication

Semester -VIII

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC801	CMOS VLSI Design	04	--	--	04	--	--	04
EXC802	Advanced Networking Technologies	04	--	--	04	--	--	04
EXC803	MEMS Technology	04	--	--	04	--	--	04
EXC804X	Elective -II	04	--	--	04	--	--	04
EXC806	Project - II		04			04	--	04
EXL801	CMOS VLSI Design Laboratory	--	02	--	--	01	--	01
EXL802	Advanced Networking Technologies Laboratory	--	02	--	--	01	--	01
EXL803	MEMS Laboratory	--	02	--	--	01	--	01
EXL804X	Elective –II Laboratory	--	02	--	--	01	--	01
Total		16	12	--	16	08	--	24

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC801	CMOS VLSI Design	20	20	20	80	-	--	--	100
EXC802	Advanced Networking Technologies	20	20	20	80	--	--	--	100
EXC803	MEMS Technology	20	20	20	80	--	--	--	100
EXC804X	Elective -II	20	20	20	80	--	--	--	100
EXC806	Project - II	--	--	--	--	50	--	50	100
EXL801	CMOS VLSI Design Laboratory	--	--	--	--	25	--	25	50
EXL802	Advanced Networking Technologies Laboratory	--	--	--	--	25		25	50
EXL803	MEMS Technology Laboratory	--	--	--	--	25	--	25	50
EXL804X	Elective –II Laboratory	--	--	--	--	25	--	25	50
Total		**--**	**--**	**80**	**320**	**150**	**--**	**150**	**700**

Elective –II

Code	**Name of Elective**
EXC8041	Robotics
EXC8042	Mobile Communication
EXC8043	Digital Control System
EXC8044	Biomedical Electronics

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC701	**Embedded 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	Ave. Of Test 1 and Test 2					
EXC701	**Embedded System Design**	**20**	**20**	**20**	**80**	**-**	**-**	**-**	**100**

Course Pre-requisite:

- EXC403: Microprocessor and Peripherals
- EXC501: Microcontroller & Applications

Course Objectives:

1. To teach scope, usage, requirements, challenges and general design methodology of embedded system
2. To apply hardware and software knowledge to develop embedded system applications according to requirement and constraints

Course Outcomes:

After successful completion of the course student will be able to

1. interpret component's functional and electrical specifications and its implication and advantage in design.
2. develop their skill to select/choose proper components, approach, and method to develop optimal system.

Module No.	Unit No.	Topics	Hrs.
1		**Fundamentals of Embedded System**	8
	1.1	Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice.	
	1.2	Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency.	
	1.3	Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML	
2		**Embedded Serial Communication**	4
	2.1	Study of basic communication protocols like SPI, SCI (RS232, RS485), I^2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	
3		**Embedded Hardware and Design**	12
	3.1	Low power hardware design (MSP430 / Cortex-M3 based Real time clock and PWM dc motor control as a case study using on chip timers and watch-dog-timers).	
	3.2	Introduction to ARM-v7-M (Cortex-M3), Comparison of ARM-v7-A (CortexA8), ARM-v7-R (CortexR4), ARM-v7-M (Cortex-M3)	
	3.3	Direct digital solution using CPLD, FPGA, its advantages, and introduction to related development methodology	
4		**Embedded Software, Firmware Concepts and Design**	16
	4.1	Embedded C-programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multithreading programming. (Laboratory work on J2ME Java mobile application).	
	4.2	Basic embedded C programs/applications for ARM-v7, using ARM-GCC-tool-chain, Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board	
	4.3	Real time operating system: POSIX Compliance , Need of RTOS in Embedded system software, Foreground/Background systems, multitasking, context switching, IPC, Scheduler policies, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS.	
	4.4	Introduction to µCOS-II RTOS, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management in µCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II.	
	4.5	Introduction Linux OS, Linux IPC usage, basic device (drivers) usage.	
5		**Simulation, Testing and Debugging Methodology and Tools**	04
	5.1	GNU Debugger (gdb), Boundary-Scan/JTAG interface concepts, Black-box, White-box testing, Hardware emulation, logic analyzer.	
6		**Embedded System Designing**	08
	6.1	Requirement analysis, Hardware blocks diagram, System model (like FSM, UML), Software architectures (modules, drivers), and Component/hardware selection, covering following cases: Hard real time/ Mission critical: Missile, Car cruise control, medical monitoring systems, process control system (temp, pressure) Soft real time: Automated vending machines, digital camera, media-player. Communication: Embedded web servers, routers, Wireless (sensor) networks.	
		Total	**52**

Recommended Books:

1. Embedded Systems, Rajkamal , TMH, 2008.
2. Frank Vahid - Embedded Systems , Wiley India, 2002
3. ARM System-on-Chip Architecture, Steve Furber - Pearson 2005
4. Jean J Labrose - MicroC / OS-II, Indian Low Price Edition 2002
5. DR.K.V.K.K. Prasad - Embedded / real time system, Dreamtech
6. Iyer, Gupta - Embedded real systems Programming , TMH
7. Embedded systems software primer, David Simon - Pearson
8. ARM System Developers Guide- Sloss, Symes, Wright, ElsevierMorgan Kaufman, 2005
9. LPC2148 Data Sheets www.arm.com
10. ARM Programers/architectural manual.
11. MSP430 architectural manual.
12. Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage Learning; Third or later 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 for final internal assessment.

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 question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC702	**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					
EXC702	**IC Technology**	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC302: Electronic Devices
- EXC303: Digital Circuits and Design
- EXC402: Discrete Electronic Circuits
- EXC502: Design With Linear Integrated Circuits
- EXC601: VLSI Design

Course Objectives:

1. To teach fundamental principles of fabrication of VLSI devices and circuits
2. To disseminate knowledge about novel VLSI devices

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate a clear understanding of CMOS fabrication flow and technology scaling
2. demonstrate a clear understanding of various MOS fabrication processes, semiconductor measurements, packaging, testing and advanced semiconductor technologies
3. discuss physical mechanism in novel devices
4. verify processes and device characteristics via simulations

Module No.	Unit No.	Topics	Hrs.
1. 0		**Environment and Crystal Growth for VLSI Technology**	8
	1.1	**Environment:** Semiconductor technology trend, Clean rooms, Wafer cleaning	
	1.2	**Semiconductor Substrate:** Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	10
	2.1	**Deposition:** Evaporation, Sputtering and Chemical Vapor Deposition	
	2.2	**Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers	
	2.3	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers	
	2.5	**Ion Implantation:** Penetration range, ion implantation systems, process considerations, implantation damage and annealing	
3.0		**Fabrication Processess Part 2**	10
	3.1	**Etching:** Wet chemical etching, dry physical etching, dry chemical etching, reactive ion etching, ion beam techniques	
	3.2	**Lithography:** Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography	
	3.3	**Device Isolation, Contacts and Metallization:** Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging	
	3.4	**CMOS Process Flow:** N well, P-well and Twin tub	
	3.5	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
4.0		**Measurements, Packaging and Testing**	10
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility, Minority Carrier Lifetime and diffusion length	
	4.2	**Packaging:** Integrated circuit packages, Electronics package reliability	
	4.3	**Testing:** Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	
5.0		**SOI, GaAs and Bipolar Technologies**	08
	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	**GaAs Technologies:** MESFET Technology, Digital Technologies, MMIC technologies, MODFET and Optoelectronic Devices	
	5.3	**Silicon Bipolar Technologies:** Second order effects in bipolar transistor, Performance of BJT, Bipolar processes and BiCMOS	
6.0		**Novel Devices**	06
	6.1	**Multigate Device:** Various multigate device configurations (device structure and important features)	
	6.2	**Nanowire:** Fabrication and applications	
	6.3	**Graphene Device:** Carbon nanotube transistor fabrication, CNT applications	
		Total	52

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, 2^{nd} 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, 1^{st} edition.
6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors*", Springer, 1^{st} edition
7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1^{st} edition.
8. James E. Morris and Krzysztol Iniewski, "*Nanoelectronic Device Applications Handbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press
10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits*", Springer

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 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 question will be selected from all the modules.

Subject Code	Course Name	Teaching Scheme	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC703	**Power Electronics II**	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	Avg. of Test 1 and Test 2					
EXC703	**Power Electronics II**	20	20	20	80	--	--	--	100

Course Pre-requisites:

- EXC 604: Power Electronics – I
- EXC 404: Principles of Control Systems

Course Objectives:

1. To enhance and expand the ideas of students for more complex power electronic systems.
2. To teach the analytical methods in power electronic systems.
3. To expose the students to various applications of power electronics in various electronics equipments and drives.

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 electronics systems in engineering fields
4. Simulate and analyze power electronic systems

Module No.	Unit No.	Topics	Hrs.
1		**Rectifiers and Inverters:**	12
	1.1	Effect of source inductance in 1-phase and 3-phase rectifiers, distortion in line current waveforms, voltage distortion for diode and SCR based rectifiers	
	1.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
2		**DC-DC Converters:**	10
	2.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters, Feedback control of these converters (PI and PID).	
3		**Power Electronic Applications**	06
	3.1	Use of power electronic systems in SMPS, Battery charging systems, UPS and Induction heating.	
4		**Power Electronic Applications in DC Drives**	10
	4.1	Various schemes of DC motor speed control, single-phase half-wave semi converter & full converter drive for separately excited DC motor, Dynamic and Regenerative braking of DC motor	
5		**Power Electronic Applications in AC Drives**	14
	5.1	Introduction to speed control of three-phase induction motor methods: i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Regenerative braking.	
		Total	**52**

Recommended Books:

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3rd Edition.
2. By M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2nd Edition.
3. Mohan, Undeland and Riobbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2nd Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2nd Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.
7. S. Bacha, I. Munteanu and A. Bratcu, Power Electronic Converters: Modeling and Control, Springer-Verlag, 2014.
8. H. Sira-Ramírez, R. Silva-Ortigoza, Control Design Techniques in Power Electronics Devices, Springer-Verlag, 2006

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 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			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC704	**Computer Communication and Networks**	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	Ave. Of Test 1 and Test 2					
EXC704	**Computer Communication and Networks**	20	20	20	80	-	-	-	100

Pre requisite :

- EXC 405: Fundamentals of Communication Engineering
- EXC:504: Digital Communication

Course Objective:

1. To ensure that students have the necessary networking skills to design, implement and analyze communication networks.
2. Students will be able to design, implement, and analyze communication networks.

Course Outcome: After Completing this course student will be able to

1. Understand the fundamentals of communication and Computer networks.
2. Have the capability of designing and analyzing data transmission protocols and data link control protocols.
3. Able to discuss major trends in industry and current research activities within the discipline.
4. Able to implement networking protocols using TCP/IP based on socket programming.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	10
	1.1	Network Hardware: Topologies, LAN, MAN, WAN, Wireless network, Home Network, Internetworks, Virtual LANs	
	1.2	Network Software: Protocol Hierarchies, Design Issues for the layers, Connection oriented and connectionless Services	
	1.3	Reference Models: Layers details of OSI, TCP/IP Models, Protocol Layers and Their Service Models	
2		**Physical-layer Services and Systems**	08
	2.1	Introduction to physical media, Coax, fiber, twisted pair, DSL, HFC	
	2.2	Data link layer services and protocols**:** Link-layer and its services, Ethernet, hubs, bridges, and switches, Link- layer addressing, Error-detection and error-correction. Parity, check-summing, CRC, Manchester encoding. Aloha protocols, Control Access Protocol, Carrier Sense	
	2.3	Multiple Access (CSMA), Local Area Networks - Ethernet, Token ring, FDDI. WiMax, cellular, satellite, and telephone networks, Bit transmission, Frequency division multiplexing. Time division multiplexing	
3		**Data Link Layer Protocol**	10
	3.1	PPP, HDLC, Stop and wait protocol	
4		**Network Layer Services and Protocols**	10
	4.1	Switching fabric, Routing and forwarding, Queues and buffering, Virtual-circuit and datagram networks, Internet protocol	
	4.2	IPv4 and IPv6, Tunneling, LS and DV algorithms. Routing in the Internet, RIP, OSPF, and BGP	
	4.3	Broadcast and multicast, Handling mobility	
5		**Reliable and Unreliable Transport-layer Protocols**	08
	5.1	GBN and SR. TCP and UDP. Port numbers, Multiplexing and de-multiplexing	
	5.2	Flow control and congestion control. Fairness, Delay, jitter, and loss in packet-switched networks	
	5.3	Bandwidth, throughput, and quality-of-service	
6		**Principles of Network Applications**.	06
	6.1	Application layer protocols such as HTTP, FTP, and SMTP,	
	6.2	Peer-to-Peer File Sharing Protocols and Architectures, ISPs and Domain name systems, Socket API and network socket programming	
		Total	**52**

Recommended Books:

1. B. A. Forouzan, “Data Communications and Networking”, TMH, Fourth Edition.
2. S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition.
1. Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition, March 2009, ISBN-13: 978-0136079675.

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 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			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7051	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	Ave. Of Test 1 and Test 2					
EXC7051	Digital Image Processing	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXS 401 : Applied Mathematics IV
- EXC 504 : Signal and Systems

Course Objectives:

1. To develop an overview of the field of image processing
2. To learn the fundamental concepts of Digital Image Processing .
3. To understand basic image enhancement and segmentation techniques.
4. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
5. To learn Image Compression and Decompression Techniques

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the concept of Digital Image processing.
2. Explain image enhancement and Segmentation technique.
3. Understand Digital Image compression and decompression techniques
4. Perform Binary Image Processing Operations

Module No.	Unit No.	Topics	Hrs.
1		**Digital Image Processing Fundamentals**	06
	1.1	**Introduction:** Background, Digital Image Representation, 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, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. Image File Formats : BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV)	
2		**Image Enhancement**	08
	2.1	Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background	
	2.2	Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering.	
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, Moments.	
4		**Binary Image Processing**	06
	4.1	Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm	
5		**Image Transform**	12
	5.1	Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform Fast Fourier Transform(FFT),	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	
6		**Image Compression:**	12
		Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria.	
	6.1	Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	
	6.2	Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	
		Total	**52**

Recommended 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

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 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			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7052	Artificial Intelligence	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	Ave. Of Test 1 and Test 2					
EXC7052	Artificial Intelligence	20	20	20	80	-	-	-	100

Course Prerequisite:

- Knowledge of linear algebra, multivariate calculus, and probability theory
- Knowledge of a programming language (MATLAB /C/C ++ recommended)

Course Objective:

1. To study basics of biological Neural Network.
2. To understand the different types of Artificial Neural Networks
3. To know the applications of ANN
4. To study fuzzy logic and fuzzy systems

Course Outcome: At the end of completing the course of Artificial Neural Networks, 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 No.	Unit No.	Topics	Hrs.
1.		**Fundamental Concepts of Neural Networks**	8
	1.1	Difference between fuzzy and crisp sets and applications of fuzzy logic and	
	1.2	Biological neurons, McCulloch and Pitts models *of* neuron, Important Terms of ANNs, McCulloch-Pitts Neuron, Hebb Network, Supervised learning,	
	1.3	Applications and scope of Neural Network	
2		**Supervised Learning Networks**	12
	2.1	Perception Networks: Adaline, Madaline	
	2.2	Back Propagation Network	
	2.3	Function Network	
3		**Unsupervised learning network**	12
	3.1	Max Net, Mexican Hat, Kohonen Self-organizing Feature	
	3.2	Maps, Learning Vector Quantization, Adaptive Resonance Theory	
4		**Associative networks**	10
	4.1	Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, Discrete Hopfield Networks	
	4.2	**Special networks:** Simulated annealing neural networks, Boltzmann machine, Brain-in-a-Box	
5		**Fuzzy logic**	10
	5.1	Fuzzy sets, Properties, Operations on fuzzy sets, Fuzzy relation Operations on fuzzy relations,	
	5.2	The extension principle, Fuzzy mean Membership functions, Fuzzification and defuzzification methods	
	5.3	Fuzzy controllers, Adaptive neuro-fuzzy information systems (ANFIS)	
		Total	**52**

Recommended Books:

1. Simon Haykin, "Neural Network a - Comprehensive Foundation", Pearson Education
2. Dr.S.N.Sivanandam,Mrs S.N. Deepa Introduction to Soft computing tool Wiley Publication
3. Satish Kumar Neural Networks:A classroom Approach Tata McGraw-Hill
4. Thimothv J. Ross, "Fuzz V Logic with Engineering Applications", McGraw -Hill
5. Rajsekaran S, Vijaylakshmi Pai, Neural Networks, Fuzzy Logic, andGenetic Algorithms, PHI
6. Hagan, Demuth, Beale, 'Neural Network Design', Thomson Learning
7. Christopher M Bishop Neural Networks For Pattern Recognition ,Oxford Publication
8. William W Hsieh Machine Learning Methods in the Environmental Sciences Neural Network and Kernels Cambridge Publication
9. Dr.S.N.Sivanandam, Dr.S.Sumathi Introduction to Neural Network Using Matlab 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 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	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC7053	ASIC Verification	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					
EXC7053	ASIC Verification	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXL304: Object Oriented Programming Methodology Laboratory
- EXC303: Digital Circuits and Design

Course Objectives:

1. To teach ASIC Verification fundamentals
2. To highlight the significance of verification in VLSI industry

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate an understanding of programmable devices and languages
2. demonstrate an understanding of verification process in VLSI systems
3. write system verilog code for VLSI systems
4. carry out verification of design successfully using simulators

Module No.	Unit No.	Topics	Hrs.
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, behavioral, gate and switch level modeling, tasks and functions	
	1.3	**Verification Basics:** Technology challenges, Verification methodology options, Verification methodology, Testbench creation, testbench migration, Verification languages, Verification IP reuse, Verification approaches, Verification and device test, Verification plans, reference design of Bluetooth SoC, Verification Guidelines	
2		**Data types, procedural statements and testbench**	08
	2.1	**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	
	2.2	**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	
	2.3	**Connecting the Testbench and Design:** Separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, top-level scope, program-module interactions, system verilog assertions, the four port ATM router, the ref port direction, the end of simulation, directed test for the LC3 fetch block	
3		**OOP and Randomization**	10
	3.1	**Basic OOP:** Class, Creating new objects, Object deallocation, 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 testbench	
	3.2	**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, common randomization problems, Iterative and array constraints, Atomic stimulus generation vs. scenario generation, random control, random number generators, random device configuration	
4		**IPC and advanced OOP**	08
	4.1	**Threads and Interprocess Communication:** working with threads, disabling threads, interprocess communication, events, semaphores, mailboxes, building a testbench with threads and IPC	
	4.2	**Advanced OOP and Testbench Guidelines:** Inheritance, Blueprint pattern, downcasting and virtual methods, composition, inheritance and alternatives, copying an object, abstract classes and pure virtual methods, callbacks, parameterized classes	
5		**Assertions and Functional Coverage**	12
	5.1	**System Verilog Assertions:** Assertions in verification methodology, Understanding sequences and properties, SystemVerilog Assertions in the Design Process, Formal Verification Using Assertions and SystemVerilog Assertions Guidelines	
	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, analyzing coverage data, measuring coverage statistics during simulation	
6		**Advanced interfaces and interfacing with C**	6
	6.1	**Advanced Interfaces:** Virtual interfaces with the ATM router, Connecting to multiple design configurations, procedural code in an interface	
	6.2	**A complete System Verilog Testbench:** Design blocks, testbench blocks, alternate tests	
	6.3	**Interfacing with C:** Passing simple values, connecting to a simple C routine, connecting to C++, simple array sharing, open arrays, sharing composite types, pure and context imported methods, communicating from C to system verilog, connecting other languages	
		Total	**52**

Recommended Books:

1. Chris Spear, "*System Verilog for Verification: A guide to learning the testbench language features*", Springer, 2^{nd} Edition
2. Stuart Sutherland, Simon Davidmann, and Peter Flake, "*System Verilog for Design: A guide to using system verilog for hardware design and modeling*", Springer, 2^{nd} Edition.
3. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "*SystemVerilog Assertions Handbook*", VhdlCohen Publishing, 3rd edition
4. *System Verilog Language* Reference manual
5. S Prakash Rashinkar, Peter Paterson and Leena Singh, "*System on Chip Verification Methodologies and Techniques*", Kluwer Academic, 1^{st} Edition.
6. *Spartan and Virtex family* user manuals from Xilinx
7. *Verilog Language* Reference manual

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 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 question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7054	**Optical Fiber 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	Ave. Of Test 1 and Test 2					
EXC7054	**Optical Fiber Communication**	20	20	20	80	-	-	-	100

Pre requisites:

- EXC503: Electromagnetic Engineering
- EXC405: Fundamentals of Communication Engineering
- EXC505: Digital Communication.

Course Objective: To teach students

1. Optical fiber wave guide structures, fabrication and signal degradation in fiber
2. The characteristics and working of various components used in optical link
3. Design and management of optical networks

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

1. understand light wave propagation through fiber
2. identify structures, materials, and components used in optical link
3. analyze transmission characteristics of fiber
4. design and management of optical fiber links

Module No.	Unit No.	Topics	Hrs.
1.		**Overview of Optical Fiber Communication**	10
	1.1	The evolution of fiber optic systems, elements of an optical fiber transmission link, block diagram, advantages of optical fiber communication, applications	
	1.2	Ray theory transmission, total internal reflection, acceptance angle, numerical aperture and skew rays	
	1.3	Modes, electromagnetic mode theory and propagation, single mode and multimode fibers, linearly polarized modes	
	1.4	Fiber material, fiber cables and fiber fabrication, fiber joints, fiber connectors, splicer	
2		**Optical Sources and Detectors**	10
	2.1	Coherent and non-coherent sources, quantum efficiency, modulation capability of optical sources	
	2.2	LEDs: Working principle and **c**haracteristics	
	2.3	Laser diodes: Working principle and **c**haracteristics	
	2.4	Working principle and characteristics of detectors: PIN and APD, noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	
3		**Components of Optical Fiber Networks**	08
	3.1	Overview of fiber optic networks, trans-receiver, semiconductor optical amplifiers	
	3.2	Couplers/splicer, wavelength division multiplexers and de-multiplexers	
	3.3	Filters, isolators and optical switches	
4		**Transmission Characteristic of Optical Fiber**	08
	4.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion and pulse broadening,	
	4.2	Dispersion shifted and dispersion flattened fibers, and non linear effects	
	4.3	Measurement of optical parameters, attenuation and dispersion, OTDR	
5		**Optical Networks**	08
	5.1	SONET and SDH standards, architecture of optical transport networks (OTNs), network topologies	
	5.2	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons.	
6		**Network Design and Management**	08
	6.1	Point to point links system considerations, link power budget, and rise time budget	
	6.2	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization.	
	6.3	Network management functions, configuration management, performance management, fault management, optical safety and service interface	
		Total	**52**

Recommended Books:

1. John M. Senior, "*Optical Fiber Communication*", Prentice Hall of India Publication, Chicago, 3rd Edition, 2013
2. Gred Keiser, "*Optical Fiber Communication*", Mc-Graw Hill Publication , Singapore, 4th Edition, 2012
3. G Agarwal, "*Fiber Optic Communication Systems*", John Wiley and Sons, 3rd Edition, New York 2014
4. S.C. Gupta, "*Optoelectronic Devices and Systems*", Prentice Hall of India Publication, Chicago, 2005.

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 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 question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL701	Embedded System Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL701	Embedded System Design Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC701** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC701**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL702	IC Technology Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL702	IC Technology Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC702** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC702**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL703	Power Electronics –II Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL703	Power Electronics –II Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC703** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC703**

Course	Course Name	Teaching Scheme	Credits Assigned

Code								
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL704	**Computer Communication Networks Laboratory**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL704	**Computer Communication Networks Laboratory**	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC704** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC704**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL705X	Elective I Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL705X	Elective I Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC705X** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC705X**

Elective – I

Code	Name of Elective
EXC7051	Digital Image Processing
EXC7052	Artificial Intelligence
EXC7053	ASIC Verification
EXC7054	Optical Fiber Communication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC706	Project - 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	Ave. Of Test 1 and Test 2					
EXc706	Project -I	--	--	--	--	25	-	25	50

Term Work:

The final year students have already under gone project assignment in their pre-final year in Mini Project I and II. In final year group of maximum **four** students will be completing a comprehensive project work based on the courses studied. The project work may be internally assigned or may be externally assigned by the research institutes, industry etc. Each group will be assigned one faculty as a supervisor. This project work in final year may be extension of the Mini Project work done in pre-final year.

The main intention of Project work is to enable students to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The Project work may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be

- Learning additional skills
- Development of ability to define, design, analysis and implementation of the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group
- The project area may be selected in which the student intend to do further education and/or may be either intend to have employment or self employment
- The topic of project should be different and / or may be advancement in the same topic of Mini Project
- The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Project work.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

Subject Code	Subject	Teaching Scheme	Credits Assigned

	Name							
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC801	**CMOS VLSI Design**	**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					
EXC801	**CMOS VLSI Design**	**20**	**20**	**20**	**80**	**--**	**--**	**--**	**100**

Course Pre-requisite:

- EXC302: Electronic Devices
- EXC303: Digital Circuits and Design
- EXC402: Discrete Electronic Circuits
- EXC502: Design With Linear Integrated Circuits
- EXC601: VLSI Design
- EXC702: 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.

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 circuits via simulations

Module	Unit	Topics	Hrs.

No.	No.		
1. 0		**CMOS analog building blocks**	8
	1.1	**MOS Models:** Necessity of CMOS analog design, Review of characteristics of MOS device, MOS small signal model, MOS spice models	
	1.2	**Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors	
	1.3	**Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing	
2.0		**Single Stage Amplifiers**	10
	2.1	**Configurations:** Basic concepts, Common source stage, Source follower, Common gate stage, Cascode stage	
	2.2	**Frequency Response and Noise:** General considerations, Common-source stage, Source followers, Common-gate stage, Cascode stage and Noise in single stage amplifiers	
3.0		**Differential Amplifiers**	10
	3.1	**Configurations:** Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell	
	3.2	Frequency response and noise in differential pair	
4.0		**MOS Operational Amplifiers**	10
	4.1	**Op-amp Design:** General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection, Noise in op-amps	
	4.2	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	
5.0		**Mixed Signal Circuits**	10
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator	
	5.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO	
	5.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Nonideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
6.0		**Analog Layout and other concepts**	04
	6.1	**Analog Layout Techniques:** Antenna effect, Resistor matching, capacitor matching, current mirror matching, floorplanning, shielding and guard rings	
	6.2	AMS design flow, ASIC, Full custom design, Semi custom design, System on Chip, System in package, Hardware software co-design	
		Total	**52**

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 Stimulation*", 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 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	Course Name	Teaching Scheme	Credits Assigned

Code								
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC 802	**Advanced Networking Technologies**	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	Ave. Of Test 1 and Test 2					
EXC 802	**Advanced Networking Technologies**	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXE704: Computer Communication Networks

Course Objectives:

1. To make students familiar with data communication technologies and how to use them to: Design, Implement, Operate, Manage enterprise networks.
2. To introduce the concept of wireless WAN,WAP and different IEEE standards.

Course Outcomes:

Upon completion of the course, students should be able to:

1. Analyze the performance of networks.
2. Determine the network performance using monitor tools..
3. Set up WLAN,PAN
4. Explain optical networking technology

Module	Unit	Topics	Hrs.

No.	No.		
1		**Emerging Wireless Technologies**	10
	1.1	**Wireless Personal Area Network** – Bluetooth Bluetooth (IEEE 802.15.1),Definitions of the Terms Used in Bluetooth, Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	1.2	Bluetooth Applications, WAP and Bluetooth Wireless Personal Area Networks (WPAN):Low Rate (LR) and High Rate (HR)Wireless Sensor Network, Usage of Wireless Sensor Networks, Wireless Sensor Network	
	1.3	Model, Sensor Network Protocol Stack, ZigBee Technology, IEEE 802.15.4 LR-WPAN Device Architecture, IEEE 802.15.3a Ultra WideBand, Radio Frequency Identification.	
2		**Optical Networking**	06
	2.1	ONET/SDH Standards, devices, DWDM, frame format, DWDM, Performance and design considerations.	
3		**WAN Technologies**	12
	3.1	**Frame:** FR concept, FR specifications, FR design and VoFR and Performance and design considerations	
	3.2	**ATM:** The WAN Protocol: Faces of ATM, ATM Protocol operations. (ATM cell and Transmission) ATM Networking basics, Theory of Operations, B-ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell	
	3.3	Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview, Control Plane AAL, Management Plane, Sub S3 ATM,ATM public services	
4		**Network Design**	08
	4.1	Network layer design, access layer design, access network capacity, network topology and Hardware and completing the access network design.	
5		**Network Security**	08
	5.1	Security threats, safeguards and design for network security	
	5.2	**Enterprise Network Security:** DMZ, NAT, SNAT, DNAT, Port Forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 Filtering	
6		**Network Management and Control**	
	6.1	Network management definitions, functional areas (FCAPS), SNMP, RMON,	08
	6.2	Designing a network management solutions, Monitoring and control of network activity and network project management	
		Total	**52**

Recommended Books:

1. Data Network Design by Darren Spohn, 3e McGraw Hill publications
2. Data Communication and Network Security by Carr and Snyder, McGraw Hill Publications.
3. Communication Networks by Leon-Garcia and Indra Widjaja, 2e, Tata McGraw-Hill Publications.
4. Information Security by Mark Stamp and Deven Shah by Wiley Publications.
5. Behrouz A Forouzan, Data communications and Networking 4th Edition,
6. McGraw-Hill Publication.
7. William Stallings, Data Computer Communications, Pearson Education
8. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
9. Eldad Perahita ,Next Generation wireless LANS, Cambridge Publication
10. Computer Networking by J. F. Kurose and K. W. Ross, Pearson Education
11. Local Area Networks by Gerd Keiser, McGraw-Hill 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 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	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC803	**MEMS 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	Ave. Of Test 1 and Test 2					
EXC803	**MEMS Technology**	20	20	20	80	-	-	-	100

Course Pre –requisite:

- EXC 404: Basic VLSI Design
- EXC 604: IC Technology

Course Objective:

- To provide a basic knowledge of MEMS processing steps and processing modules.
- 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.
- To provide an understanding of basic design and operation of MEMS sensors and transducers.

Course Outcome:

On Completion of this course Student will be able to

- Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication.
- Design and simulate MEMS devices and system using standard simulation tools.
- Develop different concepts of micro system sensors and actuators for real-world applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to MEMS**	04
	1.1	Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications	
2		**MEMS Materials and Their Properties**	10
	2.1	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications.	
3		**MEMS Fab Processes – 1**	11
	3.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography. Understanding selection of Fab processes based on Applications	
4		**MEMS Fab Processes – 2**	10
	4.1	Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging. Understanding selection of Fab processes based on Applications	
5		**MEMS Devices**	11
	5.1	Architecture, working and basic quantitative behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	06
	6.1	Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior, MEMS Reliability	
		Total	**52**

Recommended Books:

1. An Introduction to Microelectromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
2. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
3. Microsystem Design - by S. Senturia; Publisher: Springer
4. Analysis and Design Principles of MEMS Devices - Minhang Bao; Publisher: Elsevier Science
5. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition
6. Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press
7. Micromachined 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 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	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC8041	Robotics	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					
EXC8041	Robotics	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXS 301 : Applied Mathematics III
- EXS 401 : Applied Mathematics IV
- EXC 404 : Principles of Control Systems

Course Objectives:

1. To prepare students with basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3. To familiarize students with path & Trajectory planning of robots
4. To familiarize students with robot vision

Course Outcomes:

After successful completion of the course student will be able to

1. Describe kinematics and dynamics of stationary and mobile robots
2. Describe trajectory planning for robots
3. Implement trajectory generation and path planning various algorithms
4. Work in interdisciplinary projects

Module No.	Unit No.	Topics	Hrs.
1		**Fundamentals of Robotics**	03
	1.1	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames, workspace, applications	
2		**Forward & Inverse Kinematics of Robots**	09
	2.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	
	2.2	Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	
3		**Velocity Kinematics & Dynamics**	14
	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 robots, Transformation of forces and moment between coordinate frames	
4		**Robot Motion Planning**	04
	4.1	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	
5		**Potential Functions and Visibility Graphs**	08
	5.1	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods	
6		**Trajectory planning**	08
	6.1	Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	
7		**Robot Vision**	06
	7.1	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform.	
		Total	**52**

Recommended Books:

1. Robert Shilling, Fundamentals of Robotics - Analysis and control, Prentice Hall of India
2. Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011
3. 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.
4. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
5. John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
6. Aaron Martinez & Enrique Fernandez, “Learning ROS for Robotics Programming”, Shroff Publishers, First Edition, 2013.
7. 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 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 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	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8042	Mobile Communication	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	Ave. Of Test 1 and Test 2					
EXC 8042	Mobile Communication	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC 704: Computer Communication Networks
- EXC: Digital Communication

Course Objectives:

To enable the student to study, understand and appreciate the concepts of mobile communication technology.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of mobile communications
2. Differentiate between GSM and CDMA
3. Understand the evolving wireless communication technologies.
4. Understand the requirement of 4 G technology

Module No.	Unit No.	Topics	Hrs.
1		**Cellular Communication System**	10
	1.1	**I**ntroduction to Cellular Communications, Frequency reuse, Multiple Access Technologies	
	1.2	**Cellular Processes:** Channel assignment, Call Setup, Handoff strategies, interferences and system capacity	
	1.3	**Traffic Theory:** Trunking and grade of service, improving system capacity	
2		**GSM**	8
	2.1	GSM Network architecture, signaling protocol architecture, identifiers, channels, Frame structure, speech coding, authentication and security, call procedure, handoff procedure, services and features	
3		**CDMA digital cellular standard (1S-95)**.	8
	3.1	Frequency and channel specifications of IS-95, forward and reverse CDMA channel, packet and frame formats, mobility and radio resource management	
4		**3 G Mobile Communication System**	10
	4.1	2.5 G TDMA Evolution Path, GPRS, EDGE , 2.5G CDMA one cellular N/W, Need of 3G Cellular N/w, IMT 2000 Global Standard, UMTS Technology, W-CDMA Air interface, TD-SCDMA Technology, CDMA 2000 Cellular Technology	
5		**4G Wireless Standards**	8
	5.1	Need for 4G network, difference between 3G and 4G, LTE, WiMAX	
6		**Emerging Technologies**	8
	6.1	Mobile Adhoc Network, Mobile IP and Mobility Management, Mobile TCP, Wireless Sensor Networks, RFID Technology	
		Total	**52**

Recommended Books:

1. Wireless Communications - Theodore S. Rappaport, Prentice Hall of India, PTR publication
2. Mobile & Personal Communication system & Services by Raj Pandya , Prentice –Hall of India (PHI) Private Limited
3. Principles of Wireless Networks-KavehPahlavan, Prashant Krishnamurthy, PHI
4. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
5. Wireless communication- Singhal_TMH
6. Fundamentals of Wireless Communications, “David Tse and Pramod Viswanath, Publisher, Cambridge University Press.
7. Wireless Communications: Andrea Goldsmith, Cambridge 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 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	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8043	Digital Control 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	Ave. Of Test 1 and Test 2					
EXC 8043	Digital Control System	20	20	20	80	--	--	--	100

Course Prerequisites:

- EXC404: Principles of Control System
- EXC504: Signals and Systems

Course Objective:

1. To study the importance of digital control
2. To study stability analysis of digital control systems
3. To study the design of digital control systems

Course Outcomes:

1. Students will be able to differentiate between analog and digital control and importance of digital control
2. Student will be able to analyze the digital control systems
3. Students will be able to design digital controllers

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system	12
	1.2	Data conversion and quantization, sampling and reconstruction of analog signal, zero and first order hold	
	1.3	Impulse invariance, bilinear transformation, finite difference approximation of derivatives	
2.0		**Modeling of Digital Control System**	04
	2.1	Linear difference equation, pulse transfer function, input output model	
	2.2	Examples of first order continuous and discrete time systems	
	2.3	Signal flow graph applied to digital control system	
3.0		**Time Domain Analysis and Stability of Digital Control System**	08
	3.1	Mapping between s plane and Z plane, Jury's method, R. H. criteria	
	3.2	Comparison of time response of continuous and digital control system	
	3.3	Steady state analysis of digital control system, effect of sampling on transient response	
4.0		**State Space Analysis**	08
	4.1	Discrete time state equation in standard canonical form, similarity transformation	
	4.2	State transition matrix, solution of discrete time state equation	
	4.3	Discretization of continuous state space model and its solution.	
5.0		**Pole Placement and Observer Design**	10
	5.1	Concept of reachability, controllability, constructability and observability	
	5.2	Design of controller using pole placement method, dead beat controller design	
	5.3	Concept of duality, state observer design, concept of multi rate output feedback based state estimation	
6.0		**Transfer Function Approach to Controller Design**	10
	6.1	Control structures, internal stability,	
	6.2	Internal model principle and system type, well behaved signals	
	6.3	Discretization of PID controllers, pole placement controllers with performance specifications	
		Total	**52**

Recommended Books:

1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill companies, 3rd edition, 2009.
2. K. Ogata, "Discrete-Time Control Systems", PHI, 2nd edition, 2009.
3. B. C. Kuo, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
4. K. M. Moudgalya, "Digital Control", Wiley India, 2012.

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 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)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut.	Total
EXC8044	**Biomedical Electronics**	4						**4**

Course code	Course Name	Examination Scheme							
		Theory (out of 100)				Term Work	Practical and oral	Oral	Total
		Internal Assessment (out of 20)			End Sem. Exam				
		Test 1	Test 2	Avg.					
EXC8044	**Biomedical Electronics**	20	20	20	80	--	--	--	**150**

Course Pre-requisites:
- EXC305:Electronic Instruments and Measurements
- FEC102,202: Applied Physics I and II

Course Objective:
1. To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement
2. Application of these instruments in diagnosis, therapeutic treatment and imaging fields

Course Outcome:

The Students will be able to
1. Identify various Bio-potential and their specifications in terms of amplitude and frequency.
2. Understand principle and working of various Biomedical Instruments for diagnosis applications.
3. Decide the applications of therapeutic instruments for treatment purpose.
4. Understand applications of imaging instruments and the modalities involved in each technique.

Module No.	Unit No.	Topics	Hrs.
1		**Bio-Potential and Measurement**	08
	1.1	Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications.	
	1.2	Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	
2		**Physiological Systems and Related Measurement**	14
	2.1	Respiratory system- Physiology of respiration and measurements of respiratory related parameters	
	2.2	Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias	
	2.3	Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and its measurement. Normal and abnormal EEG, evoked potential and epilepsy	
	2.4	Muscular system- Generation of EMG signal, specification and measurement.	
		Design of ECG amplifier	
3		**Cardiovascular Measurement**	08
	3.1	Blood Pressure- Direct and Indirect types. Blood Flow- Electromagnetic and Ultrasonic types. Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric) Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type. Heart sound measurement	
4		**Life support Instruments**	08
	4.1	Pacemaker- Types of Pacemaker, mode of pacing and its application. Defibrillator- AC and DC Defibrillators and their application. Heart Lung machine and its application during surgery. Haemodialysis system and the precautions to be taken during dialysis. Baby Incubator and its application	
5		**Imaging Techniques**	10
	5.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its application	
	5.2	CT Scan- CT Number, Block Diagram, scanning system and application. Ultrasound Imaging- Modes of scanning and their application	
	5.3	MRI- Concepts and image generation, block diagram and its application	
6		**Significance of Electrical Safety**	04
	6.1	Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention.	
		Total	**52**

Recommended Books:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
2. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3. R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004
4. Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.
6. John E Hall, Gyton's Medical Physiology, 12th 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 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	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 801	CMOS VLSI Design Laboratory	--	02	--	--	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	Ave. Of Test 1 and Test 2					
EXL801	CMOS VLSI Design Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC801** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC801**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 802	**Advanced Networking Technologies Laboratory**	--	02	--	--	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	Ave. Of Test 1 and Test 2					
EXL802	**Advanced Networking Technologies Laboratory**	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC802** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC802**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 803	**MEMS Technology Laboratory**	--	02	--	--	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	Ave. Of Test 1 and Test 2					
EXL803	**MEMS Technology Laboratory**	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC803** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXC803**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 804X	Elective –II Laboratory	--	02	--	--	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	Ave. Of Test 1 and Test 2					
EXL 804X	Elective –II Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXE804X** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The 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.
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 of **EXE804X**.

Elective –II

Code	Name of Elective
EXC8041	Robotics
EXC8042	Mobile Communication
EXC8043	Digital Control System
EXC8044	Biomedical Electronics

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC806	Project - II	--	04	--	--	02	--	02

Course Code	Course 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					
EXC806	Project - II	--	--	--	--	50	-	50	100

Term Work:

The final year students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Design, implementation, and analysis of the project work.
- Results, conclusions and future scope.
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

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 $2\pi \text{ and } 2l$	**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**

<u>Assessment</u>:

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.**

<u>**Assessment**</u>**:**

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, $1/7^{th}$ 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

<u>Assessment</u>:

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 2nd Edition, 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,2nd Edition, 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**

<u>Assessment</u>:

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**

<u>Assessment</u>:

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),**<u>Learners (in a group) may be encouraged for Project Based Learning. Appropriate weightage may be given in term work assessment</u>**

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.**

<u>Assessment:</u>

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**

<u>Assessment</u>:

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, 8th Edition, Khanna Publishers
7. Bosch Automotive Hand Book, 6th Edition, 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

<u>Assessment</u>:

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, 10^{th} 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 General 2^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 73^{rd} 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**

<u>Assessment</u>:

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

<u>Assessment</u>:

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**

<u>Assessment</u>:

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 efficien cy 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 o f 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

<u>Assessment</u>:

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

<u>Assessment</u>:

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

<u>Assessment</u>:

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	

<u>Assessment</u>:

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, (2^{nd}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

<u>Assessment</u>:

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.

<u>Assessment</u>:

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. 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

****

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 No. 4.126

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

AMajumdar
Dr. Anuradha Majumdar
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

<u>Assessment</u>:

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

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Theory</th><th>Practical /Oral</th><th>Tutorial</th><th>Total</th></tr>
<tr><td>ITC305</td><td>Paradigms and Computer Programming Fundamentals</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
</table>

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="7">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Pract. /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.</th></tr>
<tr><td>ITC305</td><td>Paradigms and Computer Programming Fundamentals</td><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>100</td></tr>
</table>

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 (2nd 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:	**Software requirement:**
PC i3 processor and above	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

<table>
<tr><td></td><td></td><td>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.</td><td></td><td></td></tr>
<tr><td>II</td><td>Classes, objects, Arrays and Strings</td><td>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:
<table><tr><td>Name</td><td>Year of joining</td><td>Address</td></tr><tr><td>Robert</td><td>1994</td><td>64C- WallsStreat</td></tr><tr><td>Sam</td><td>2000</td><td>68D- WallsStreat</td></tr><tr><td>John</td><td>1999</td><td>26B- WallsStreat</td></tr></table>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.</td><td>07</td><td>LO1
LO2</td></tr>
</table>

		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

.

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

<table>
<tr><td rowspan="2">Lab Code</td><td rowspan="2">Lab Name</td><td colspan="3">Teaching Scheme (Contact Hours)</td><td colspan="4">Credits Assigned</td></tr>
<tr><td>Theory</td><td>Practical</td><td>Tutorial</td><td>Theory</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>ITL401</td><td>Network Lab</td><td>--</td><td>02</td><td>--</td><td>--</td><td>01</td><td>--</td><td>01</td></tr>
</table>

<table>
<tr><td rowspan="4">Lab Code</td><td rowspan="4">Lab Name</td><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Marks</td><td rowspan="3">Term Work</td><td rowspan="3">Pract. /Oral</td><td rowspan="3">Total</td></tr>
<tr><td colspan="3">Internal assessment</td><td rowspan="2">End Sem. Exam</td></tr>
<tr><td>Test1</td><td>Test 2</td><td>Avg.</td></tr>
<tr><td>ITL401</td><td>Network Lab</td><td>--</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td><td>50</td></tr>
</table>

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: PC i3 processor and above	**Software requirement:** 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

University of Mumbai

CIRCULAR:- No. UG/ 44 of 2019-20

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 15/4/2019
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	1	--	5
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**	**10**	**4**	**17**	**5**	**4**	**26**

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	--	--	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	25	--	--	100
CE-P804	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-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.
•To study the arbitration process.
•To study assessment of the value of a property.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**Introduction**		**03**
	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**		08
	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**		08
	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**		09
	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:
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 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.

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 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:
1) At least **eight** assignments based on entire syllabus

2) 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

3) 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**	**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**	**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

1. 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.
2. To study the various clauses of IS: 456-2000 and its significance in the RCC design.
3. To apply the 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 study the concept of reinforced concrete footing design subjected to axial load and moment.
6. To develop the concept of design using ready charts and curves for column subjected to axial load and moments.

Detailed Syllabus

Module	Contents	Periods
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	12

	flexure, shear by WSM, Analysis and design of Cracked and un-cracked RCC column sections by WSM	
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
	Total	52

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

1. Understand the pros and cons of the WSM and LSM.
2. Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
3. **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.**
4. **Understand and the use of readymade design curves from Special publications of Bureau of Indian standards.**

Theory Examination:-

1. **Use of IS:456-2000 shall be allowed in the examination.**
2. Question paper will comprise of **six** questions; each carrying 20 marks.
3. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
4. 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 the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
5. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
6. The students will have to attempt any **three** questions out of remaining five questions.
7. 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 Marks

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**	**04 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

1. To understand different types of dams and its suitability to a particular region.
2. To study design consideration of earthen dams
3. To study various types of Spillways
4. To understand the importance of silt theories for design of irrigation channels
5. To study the classification of canals and design of canal system.

Detailed Syllabus

Module	Topics	Periods
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, advantagSes, 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:

1. Design the section of gravity dams, earth and rockfill dams, arch dams and buttress dams.
2. Design spillways and energy dissipaters.
3. Apply silt theories to design irrigation canals.
4. Explain various types of canals and its maintenance.
5. 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-module and contents thereof further.

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	**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**	**Average**						
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 prestressed concrete which is used in a wide range of building and civil structures. A Prestressed Concrete section improves performance/efficiency, reduces structural thicknesses, and material savings compared with simple reinforced concrete sections. Typical applications of prestressed concrete include high rise buildings, residential slabs and bridge structures etc.

Objectives

1. To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of prestressed section over R. C. C. as a civil engineer.
2. To make the candidate to understand the 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	**Sub module/Contents**	**Periods**
1	**Introduction to prestressed concrete and analysis of prestressed concrete section :** Basic concept and general principles, materials used and their properties, methods, techniques and systems of prestressing	04
2	**Analysis of Prestressed 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
3	**Losses in prestress:** 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
4	**Analysis of Prestressed Concrete Members in Limit State of Serviceability deflection:** Short time and long time deflection of uncracked members, permissible limits	03
5	**Analysis and Design of Prestressed Concrete Members for Limit State of Collapse Shear** Calculation of principle tension, permissible principle tension, Analysis and	05

	Design of members in shear (sections uncracked in flexure)	
6	**Analysis and Design of Prestressed Concrete Members for Limit State of Collapse Flexure** General philosophy of design, Analysis and design of members in flexure	03
7	**Analysis and Design of Prestressed Concrete Members for Limit State of Serviceability Cracking** permissible stresses in concrete and steel at different stages, suitability of section, safe cable zone	05

Contribution to outcome

On successful completion of the course, the students shall be able:

1. To understand the concept of pre-stressing its casting techniques and applications, behaviour of the pre-stressed structures vis-à-vis that of the RCC structure.
2. To take the decision with respect to the choice of pre-stressed section over RCC.
3. To analyze the various pre-stressed components of the structure and design the same using relevant IS Code.

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 **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, 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	**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	Periods
1.	**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
2.	**Generation and characteristics of waste** Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes	03

3.	**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
4.	**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
5.	**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
6.	**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:-

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, 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.

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.

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.

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.

1. Report (on any industrial/hazardous/municipal solid waste/site visit): 05 Marks
2. Seminar : 05Marks
3. Attendance : 05 Marks
4. 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	**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	Periods
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*, Khana 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	**Structural Dynamics**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**4**

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	**10**
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	**12**

	Approximate method of determination of natural frequencies of vibration and mode shapes – Energy methods	
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.	**12**
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 are expected to understand the difference between static and dynamic loads and analysis. They are expected to evaluate the response of SDOF and Two DOF systems to different types of dynamic loads including ground motions. They are also expected to understand the basics of random vibrations and the application of this concept to 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:
1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
3. The students will have to attempt any **four** questions out of **total six** questions.
4. The questions can be of **mixed nature** irrespective of modules.

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. CloguhandPenzein: ‘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 VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7045	**Applications of Geographic Information Systems & Remote Sensing**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	--	02	04	--	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

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	Periods
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,	8

	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)	
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.	**6**

Contribution to Outcomes

After completion of course, student will be able to:
CO1. Explain the principles of physics of Electromagnetic radiation as applied to remote sensing.
CO2. Describe Spatial and non-spatial database of geographic information system
CO3 Demonstrate the GPS Satellites & their Segments.
CO4. Apply the GIS & RS techniques in Water Resources & Environmental Management.
CO5. Integrate the GIS-GPS & RS techniques for Infrastructure Management
CO 6 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 GeographicInformationSystems:Kang-TsungChang,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, SpatialAnalysis, andModeling: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. RemoteSensingandImageInterpretation: LillesandandKiefere:, JohnWiley,1987.
8. GlobalPositioningSystem: Signals, Measurements, andPerformance, PratapMisraandPe r Enge(2nd Ed.), 2006.
9. Introduction to geomatics –QGIS user guide – Mr.C.V. Nishinkanth, Mrs.AnnuNishinkanth, Dr S S Vasudevan, Dr P Ramkumar, Publishers-

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**	**04 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**	**Periods**
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, 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	**08**

	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

1. On successful completion of the course, the learner shall have an: 1. Ability to identify, formulate and solve geotechnical engineering problems
2. Ability to design a suitable foundation system from economic and safe aspects
3. Ability to design machine foundations
4. Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.
5. Ability to understand design of sheet piles
6. Ability to analyze vertical stresses developed in soil and used in practical problems

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, 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.

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.

5. Attendance : 05 Marks

6. 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-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**	**Periods**
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:**	7

	Design of Cantilever and Counterfort retaining wall	
IV	**DESIGN OF WATER TANK** Classification of Water Tank, Permissible Stresses, design ofcircular 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	**PRESTRESSED CONCRETE:** Prestressed Concrete: Basic principles of prestressed concrete, materials used, systems of prestressing, losses in prestress, analysis of beam sections at transfer and service loads.	7
Total		**52**

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:-

8. 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.
9. The **first** question will be based on design project from following. (any one out of given two is to be answered)
   a) Design of slab and continuous beam (max three span) or design of column from terrace to footing.
   b) Design of counterfort retaining wall
   c) Design of overhead water tank including design of staging
10. The next four questions will be based on remaining modules of syllabusand 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.
11. 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:

1. Design report of (G+3) building using relevant IS codes.
2. Design report of counter fort retaining wall OR overhead water tank and staging.
3. Report of one site visit to under construction building/PSC site.
4. 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.

1. Design report and drawing sheets : 15marks
2. Assignments and site visit report: 05 marks
3. 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:-

18. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
19. Limit State Design – Reinforced Concrete: *Shah and Karve,* Structure Publications, Pune.
20. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand& bro.
21. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
22. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve,* Structure Publications, Pune.
23. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A,John Wiley.
24. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons.
25. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
26. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House,NewDelhi
27. Prestressed concrete, problems and solutions , Krishna Raju, CBS Publishers and distributors, New Delhi.
28. Prestressed concrete : N. Rajgopalan, Narosa Publishers.
29. Earthquake resistant design of structures: S. K. Duggal, Oxford University Press.
30. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
31. 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**	**04 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 learn scheduling techniques such as CPM &PERT.
- To gain knowledge of time-cost optimization & effective utilization of resourceson 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**	**Periods**
I	**Introduction to Construction Management:** 1.1 Concept of Management, Principles of management, contribution byeminent personalities towards growth of management thoughts. 1.2 Significance of construction, management, objectives& functions of construction management 1.3 Resources required for construction.	04
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. 2.4Roles 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	05

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 anetwork 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	**Safety & Health on Construction Sites** 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	03
VII	**Quality Control :** 7.1 Concept of Quality, quality control check list in quality control etc. 7.2 Role of inspection in quality control, 7.3 Quality manual, Quality assurance statistical quality control 7.4 ISO14000	03
VIII	**Construction Labors& Legislation :** 8.1 Need for legislation & Importance of labour laws. 8.2 Acts applicable to Indian construction labours such as Payment of wages act, Minimum wages act, Workmen's compensation act, Factories act etc.	03

Contribution to Outcomes

On completion of the course, the learners will be able to:-

1) understand & 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 the resources to the project.
4) develop optimum relationship between time & cost for construction projects
5) Implement quality & safety measures on construction sites during execution of civil engineering projects.
6) Understand the importance of labour legislation

Term Work: At least 10 assignments covering the entire syllabus.

Theory Examination:

1) The question paper will comprise of six questions, each carrying 20 marks.
2) The first question will be compulsory & out of remaining questions students have to attempt Any three questions.
3) 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.Seetaraman.
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	**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**	**04 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 of various relevant IS codes for designing such special steel structures

Detailed Syllabus		
Module	**Sub – Modules / Contents**	**Periods**
I	**1. Introduction to Steel Structure**	**03**
	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.	
	2. Moment Resistant Beam End Connections :	**05**
	Design of moment resistant bolted and welded beam end connections by limit state method	
II	**3. Round Tubular Structural Members :**	**06**

	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.	
III	**4. 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	**5. Gantry Girder :**	**O7**
	Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	
V	**6. Lattice Tower :**	**09**
	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)	
VI	**7. Steel Chimney :**	**08**
	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)	

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 watertank
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.

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 VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8032	**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**	**04 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**	**Periods**
1	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**
2	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	**04**
3	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**
4	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**
5	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**
6	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

1. Understand the characteristics of industrial wastewater.

2. Identify sampling method and analyze industrial waste.

3. Design facilities for the processing and reclamation of industrial waste water.

4. Explain on-site treatment methods and solve Analyze and design wastewater treatment systems. (floatation, vacuum filtration, centrifugation, filter press and membrane filters)

5. Detailed on-site manufacturing processes and treatments of industrial waste water.

6.Analyze proposed development project plans for possible environmental effects and to improve treated effluent quality to confirm standard prescribed by regulatory agencies.

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, 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.

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.

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.

7. Report (on any industry/site visit): 05 Marks
8. Seminar : 05Marks
9. Attendance : 05 Marks
10. 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,Tata mcgraw 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	**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**	**04 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**	**Periods**
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:-

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 **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 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	**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**	**04 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, prestressed 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 utmostimportance. 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 Prestressed Concrete bridges for IRC loads along withbasics 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

1. To bring the students to such a levelthat 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.
2.To make the candidate to understand the analysis and design of reinforced concrete culvert/Prestressed Concrete bridges using relevant IRCs.
3. 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**	**Periods**
1	**Introduction:** Types of Bridges, Selection of suitable site and type of bridge, Components of a bridge, aesthetics, economic span	06
2	**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, Prestressed Concrete deck slab and girdered bridge, **IRS loads**: Railway loading and distribution on lattice girder bridge	10

3	**Design of Superstructure:** Design of prestressed 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
4	**Substructure:** Different types of foundations, their choice and methods of construction, well foundation, pile foundation,piers and abutments, wing walls	06
5	**Bearing:** Various types of bearings and their suitability	03
6	**Construction Methods:** Various methods of erection of bridge girders, cantilever method of construction of bridge	03

Contribution to outcome

On successful completion of the course, the student shall be able to:
1. Select the suitable type of bridge according to the site condition.
2. Understand IRC loads, distribution of these loads on deck slab and among longitudinal beams/girders of a bridge.
3. Design of culvert, balanced cantilever reinforced concrete bridge, prestressed concrete deck slab bridge, I-girdered and box girdered bridge, lattice girder railway bridge.
4. Understand different types of foundations, piers and abutments, their methods of construction.
5. Understand various types of bearings and their suitability, erection of bridge superstructure.

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 **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.

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

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	**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 studentsunderstand 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**		**Periods**
I.	**Construction Projects and Report Preparation**		**04**
	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**		**08**
	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.	
		Total	**48**

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**a 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:

4) Minimum **Six assignments** covering the entire syllabus**.**
5) **Report** on studying the SWOT Analysis of any one major infrastructure project.
6) **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 Marks

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	**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 andstructures.

Objectives

- To study fundamental concepts of vibrations, degrees of freedom and damping systems.
- To study phenomena like liquefaction and theireffects.
- To study principals of machine foundation design and dynamic earth pressure theories on retainingwall.
- To learn test methods of evaluating dynamic properties ofsoil.

Detailed Syllabus		
Module	**Sub- Modules/Contents**	**Periods**
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 liquefactionpotentials, 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 ofsoil 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.	**07**
VII.	Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure,point of application of the resultant, simple examples.	**07**

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 tovibrations.
- Provide an impetus to new developments in related dynamictopics.

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 entiresyllabus.

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 contentsthereof.

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 fivequestions.

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 thatthestudents 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 bookcompany
2. Principles of Soil Dynamics: *Braja, M. Das,* PWS-Kent PublishingCompany
3. Dynamics of Bases and Foundations: *Barkan, D. D.,* McGraw- Hill Bookcompany
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 IScodes

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8037	**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 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	Periods
I	**Introduction:** Hydrological cycle, scope of hydrology, water budget equation, sources of data. **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.	7
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.	7
III.	**Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	6
IV.	**Hydrograph Analysis:** Characteristics, base *flow* separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	7
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.	6
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.	6

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 station, average rainfall and missing rainfall over catchment
- Describe various methods of measurement of stream flow and to calculate obstraction losses over the catchment
- Develop rainfall runoff relationship and calculating runoff over catchment
- Perform hydrologic and hydraulic routing

- Derive the equation 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 BookHouse. Delhi.
- Elementary Hydrology: *V. P. Singh*, Prentice Hall
- Engineering Hydrology: Principles and practice*: V. M. Ponce*, Prentice Hall

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

****

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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 601	Embedded Systems& Real Time Operating System	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^2MOS, 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO6024	Computer Organization and Architecture	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
ELXLDLO703 X	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
ELXLDLO804 X	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

<u>Assessment</u>:

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, 10^{th} 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

<u>Assessment</u>:

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

<u>Term Work</u> :-

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

Subject Code	Subject Name	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

<u>Recommended Books</u> :-

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

<u>Assessment</u>:

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
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	**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.,	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, (2^{nd}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

<u>Term Work</u> :-

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

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).

(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/4.54/05/05/2018

****

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, 2nd Edition.

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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 601	Embedded Systems& Real Time Operating System	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^2MOS, 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** 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	06
2	**HARDWARE DESIGN & TESTING METHODS** 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	10
3	**SOFTWARE DESIGN & TESTING METHODS** 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	10
4	**PRINTED CIRCUIT BOARD (PCB) DESIGNING** 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	08
5	**PRODUCT DEBUGGING & TESTING** 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	08
6	**THE DOCUMENTATION PROCESS** 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	06
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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO6024	Computer Organization and Architecture	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	Dur a tion (hrs)					
		Test 1	Test 2	Av g							
ELXL DLO6 021	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
ELXLDLO703 X	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
ELXLDLO804 X	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

Subject Code	Subject Name	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

<u>Recommended Books</u> :-

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

<u>Assessment</u>:

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	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.,	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, (2nded), 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

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 1.2 1.3 1.4 1.5	Definition of random process, Specifying random process Examples of discrete time and continuous time random processes Stationary random process Time Averages of random processes	
02		**Error Control Coding**	**12**
	2.1 2.2 2.3	Concept of Convolutional codes and its representation, transfer function, Convolutional Interleaving, Decoding of Convolutional codes (Viterbi decoding), and their performance in communication systems. Turbo codes:-concepts, log-likelihood algebra, product code, Encoding with recursive systematic codes, Trellis decoding. Low-density Parity-check codes:-construction, minimum distance of LDPC codes	
03		**Signaling over Band limited channel**	**08**
	3.1 3.2 3.4	Optimum receiver for channels with ISI and AWGN, Optimum maximum likelihood receiver, discrete time model for a channel with ISI. Linear Equalization: Peak distortion criteria, mean square error criterion , Performance characteristics of MSE equalizer. Decision feedback equalization: Co-efficient optimization, performance characteristics of Decision feedback equalizer, Iterative Equalization and Decoding- Turbo equalization	
04		**Adaptive Equalizer**	**06**
	4.1 4.2	Adaptive linear Equalizer:-Zero forcing algorithm, LMS algorithm, convergence properties of LMS algorithm. Self recovering (Blind) equalization based on maximum likelihood criterion.	
05		**Signaling over fading channels**	**10**
	5.1 5.2 5.3	Channel model for Time variant multipath channels, classification of multipath channels, Signal design for fading multipath channels. Performance Improvement through signal diversity, Rake receiver and multipath diversity, recombining techniques. 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 6.2	Multiple access techniques: TDMA, FDMA, CDMA, Multichannel Digital Communication in AWGN Channels. 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**

<u>Reference Books</u>:-

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

<u>Assessment</u>:

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

<u>Assessment</u>:

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.**

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 (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

<u>Suggested List of Experiments (Any six)</u> :-

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** 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.	08
2	**Hardware Description Language VHDL** Introduction, Code structure, Data types, Concurrent and sequential codes, Signals and variables. Examples like Multiplexers, De-multiplexers, Adder, Flip Flops, Counters, Registers .	14
3	**Design of Finite State Machines (FSM) using VHDL** VHDL code for Moore, Mealy type FSMs, Serial adders, ASM charts, traffic light controller, vending machines.	12
4	**System Design** Bit counting circuits, serial and parallel multipliers, dividers, implementation of Booth's algorithm, MAC design.	11
5	**Programmable Logic Devices** PLDs, CPLD, SRAM based FPGA architecture, Spartan II.	03
6	**Simulation and Synthesis** Functional simulation, timing simulation, logic synthesis, RTL.	04
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.
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 (Hours)</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>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>

<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>Test 1</th><th>Test 2</th><th>Average</th></tr>
<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 **1.2** **1.3**	Wireless Network operation: topologies: Infrastructure networks and Adhoc networks, Mobility Management – Mobile IP operation of Mobile IP, Discovery, Registration, and Tunneling. Power control & Power saving Mechanisms in Wireless networks, Energy efficient designs and Energy efficient software approaches Overview of Wireless LAN: 802.11 Architecture, Medium Access Control: CSMA /CA , DCF , PCF , MAC Frame	
02		**Mobile ADHOC Networks (MANETs)**	**08**
	2.1 **2.2**	Ad hoc wireless networks: Issues in Ad Hoc wireless networks, Issues in designing MAC Protocol for Ad Hoc networks, Classification of MAC protocols 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 **3.2** **3.3**	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 Multicast Routing in MANETs: introduction and Classification of Multicast routing protocols 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 **4.2** **4.3**	Introduction and overview of WSN: Sensor Network Architectural Elements, Basic Wireless sensor technology: Sensor node technology, Applications of WSN: Category 1 WSNs and Category 2 WSNs Challenges and hurdles in WSN. Data Gathering ,MAC Protocols for WSN: Schedule based protocols , Random- Access based protocols	
05		**Routing protocols for Wireless sensor networks**	**10**
	5.1 **5.2** **5.3**	Routing Challenges and Design issues in WSN ,Data Dissemination, Routing strategies in WSN : Proactive , Reactive hybrid strategies Data centric Routing Protocol: SPIN Hierarchical Routing protocol : LEACH	
06		**Recent Advances in Wireless networks**	**06**
	6.1 **6.2**	Cognitive Radio Networks : Spectral sensing , white holes, Spectrum management 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.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELEXDLO2024	Mechatronics	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					
ELXDLO2024	Mechatronics	20	20	20	80	---	---	---	100

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, 2nd 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.

<u>Research Publications</u> :-

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, 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
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	Enterprenuership 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, 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
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, (2^{nd}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.**

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
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)