UNIVERSITY OF MUMBAI

Revised Syllabus for the

M.E.(Electronics Engineering)
Course: Electronics Engineering

**As per Choice Based Credit and Grading System
with effective from the academic year 2016-17**

From Co-ordinator's Desk:-

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

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for Master of Engineering from the academic year 2016-2017.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

Quality of education is one of the major factors to contribute to the growth of a nation and subsequently quality of education is largely decided by the syllabi of the Educational Programme and its proper implementation. In order to make M.E (Electronics) Engineering programme of University of Mumbai rich in quality, revision of the syllabi is being undertaken as per the guidelines of University of Mumbai. While deciding the core courses and department level optional courses, inputs from various stake holders were taken into account. The exposure to the latest technology and tools used all over the world is given by properly selecting courses and their hierarchy in the programme curriculum. Thus this syllabus is made to groom the postgraduate students to be made competent in all respect with best possible efforts put in by the experts in framing detailed contents of individual courses.

I, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, am happy to state here that, heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational Objectives as listed below as per National Board of Accreditation (NBA) guidelines.
1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that small step taken in right direction will definitely help in providing quality education to the stake holders.

Finally, I express my sincere gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr. Sudhakar S Mande
Chairman BOS Electronics Engineering

Programme Structure for Master of Engineering– Electronics Engineering
(With effect from Academic Year 2016 – 2017)

SEMESTER – I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1011	Advanced Digital Communication	04	---	---	04	---	---	04
ELXC1012	Mixed Signal VLSI Design	04	---	---	04	---	---	04
ELXC1013	Power Electronics System Design	04	---	---	04	---	---	04
ELXDLO101X	Department Level Optional Course-I	04	---	---	04	---	---	04
ILO101X	Institute Level Optional Course -I	03	---	---	03	---	---	03
ELXL1011	Laboratory-I Advanced Digital Communication	---	02	---	---	01	---	01
ELXL1012	Laboratory-II Mixed Signal VLSI Design	---	02	---	---	01	---	01
TOTAL		19	04	---	19	02	---	21

Course Code	Course Name	EXAMINATION SCHEME – SEMESTER I							
		THEORY					MAXIMUM MARKS		
		INTERNAL ASSESSMENT (IA)			End Semester Examination (Marks)	Exam Duration (Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC1011	Advanced Digital Communication	20	20	20	80	03	---	---	100
ELXC1012	Mixed Signal VLSI Design	20	20	20	80	03	---	---	100
ELXC1013	Power Electronics System Design	20	20	20	80	03	---	---	100
ELXDLO101X	Department Level Optional Course-I	20	20	20	80	03	---	---	100
ILO101X	Institute Level Optional Course-I	20	20	20	80	03	---	---	100
ELEXL1011	Laboratory-I Advanced Digital Communication	---	---	---	---	---	25	25	50
ELEXL1012	Laboratory-II Mixed Signal VLSI Design	---	---	---	---	---	25	25	50
TOTAL		100	100	100	400	---	50	50	600

SEMESTER – II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2021	Digital Design with Reconfigurable Architecture	04	---	---	04	---	---	04
ELXC2022	Real Time System Design	04	---	---	04	---	---	04
ELXC2023	Advanced Signal Processing	04	---	---	04	---	---	04
ELXDLO202X	Department Level Optional Course II	04	---	---	04	---	---	04
ILO202X	Institute Level Optional Course-II	03	---	---	03	---	---	03
ELXL2021	Laboratory-III Digital Design with Reconfigurable Architecture	---	02	---	---	01	---	01
ELXL2022	Laboratory-IV Advanced Signal Processing (ASP)	---	02	---	---	01	---	01
TOTAL		19	04	---	19	02	---	21

Course Code	Course Name	EXAMINATION SCHEME – SEMESTER II							
		THEORY					MAXIMUM MARKS		
		INTERNAL ASSESSMENT (IA)			End Semester Examination (Marks)	Exam Duration (Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC2021	Digital Design with Reconfigurable Architecture	20	20	20	80	03	---	---	100
ELXC2022	Real Time System Design	20	20	20	80	03	---	---	100
ELXC2023	Advanced Signal Processing	20	20	20	80	03	---	---	100
ELXDLO202X	Department Level Optional Course-II	20	20	20	80	03	---	---	100
ILO202X	Institute Level Optional Course -II	20	20	20	80	03	---	---	100
ELXL2021	Laboratory-III Digital Design with Reconfigurable Architecture	---	---	---	---	---	25	25	50
ELXL2022	Laboratory-IV Advanced Signal Processing (ASP)	---	---	---	---	---	25	25	50
TOTAL		100	100	100	400	---	50	50	600

Course Code	Department Level Optional Course-I (ELXDLO101X)	Course Code	Department Level Optional Course-II (EXCDLO202X)
ELXDLO1011	Advanced Processor Architecture-I	ELXDLO2021	Advanced Processor Architecture-II
ELXDLO1012	Network & System Administration	ELXDLO2022	Wireless & Mobile Networking
ELXDLO1013	Microelectronics Devices	ELXDLO2023	Nanoelectronics
ELXDLO1014	Modeling & Simulations	ELXDLO2024	Mechatronics
ELXDLO1015	Advanced Digital Image Processing	ELXDLO2025	Virtual Instrumentation

Course Code	Institute Level Optional Course-I (ILO101X)	Course Code	Institute Level Optional Course-II (ILO202X)
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and CSR
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management

SEMESTER III

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXS3031	Seminar	---	06	---	---	03	---	03
ELXD3031	Dissertation-I	---	24	---	---	12	---	12
TOTAL		---	30	---	---	15	---	15

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXS3031	Seminar	---	---	---	---	50	---	50	100
ELXD3031	Dissertation-I	---	---	---	---	100	---	---	100
					TOTAL	150		50	200

SEMESTER IV

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXD4041	Dissertation-II	---	30	---	---	15	---	15
TOTAL		---	30	---	---	15	---	15

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXD4041	Dissertation-II	---	---	---	---	100	---	100	200
					TOTAL	100		100	200

Note:
- In case of Seminar (ELXS3031), 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I (ELXD3032) and Dissertation II (ETXD4041), 02 Hour / week / student should be considered for the calculation of load of a teacher

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1011	Advanced Digital Communication	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1011	Advanced Digital Communication	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Digital Communication

Course Objectives:-

1. To understand the concepts of random processes in communication systems.
2. To comprehend the error correcting codes and fundamental limits of their performance
3. To analyze different equalization techniques for channels with ISI and AWGN
4. To understand signal diversity and explore MIMO systems
5. To study multichannel and multicarrier systems

Course Outcomes:-

1. Ability to understand the nature of random processes and its statistical characteristics.
2. Ability to appreciate the importance of error correcting codes-Turbo and LDPC
3. Ability to analyze various equalizers and their use in communication systems.
4. Ability to identify the drawbacks of multipath systems and methods to overcome them.
5. Ability to understand and analyze multichannel and multicarrier systems.

Module No.	Unit No.	Topics	Hrs.
01		**Review of Random Processes**	**06**
	1.1	Definition of random process,	
	1.2	Specifying random process	
	1.3	Examples of discrete time and continuous time random processes	
	1.4	Stationary random process	
	1.5	Time Averages of random processes	
02		**Error Control Coding**	**12**
	2.1	Concept of Convolutional codes and its representation, transfer function, Convolutional Interleaving, Decoding of Convolutional codes (Viterbi decoding), and their performance in communication systems.	
	2.2	Turbo codes:-concepts, log-likelihood algebra, product code, Encoding with recursive systematic codes, Trellis decoding.	
	2.3	Low-density Parity-check codes:-construction, minimum distance of LDPC codes	
03		**Signaling over Band limited channel**	**08**
	3.1	Optimum receiver for channels with ISI and AWGN, Optimum maximum likelihood receiver, discrete time model for a channel with ISI.	
	3.2	Linear Equalization: Peak distortion criteria, mean square error criterion , Performance characteristics of MSE equalizer.	
	3.4	Decision feedback equalization: Co-efficient optimization, performance characteristics of Decision feedback equalizer, Iterative Equalization and Decoding- Turbo equalization	
04		**Adaptive Equalizer**	**06**
	4.1	Adaptive linear Equalizer:-Zero forcing algorithm, LMS algorithm, convergence properties of LMS algorithm.	
	4.2	Self recovering (Blind) equalization based on maximum likelihood criterion.	
05		**Signaling over fading channels**	**10**
	5.1	Channel model for Time variant multipath channels, classification of multipath channels, Signal design for fading multipath channels.	
	5.2	Performance Improvement through signal diversity, Rake receiver and multipath diversity, recombining techniques.	
	5.3	MIMO systems- Basic considerations, Channel Models for Multiple antenna system, signal transmission through slow fading frequency nonselective and frequency selective MIMO Channels.	
06		**Multichannel and Multicarrier system**	**10**
	6.1	Multiple access techniques: TDMA, FDMA, CDMA, Multichannel Digital Communication in AWGN Channels.	
	6.2	Multicarrier Communication: Single carrier versus Multicarrier modulation, Capacity of Non-ideal linear filter channel, OFDM modulation and demodulation in an OFDM system, Spectral Characteristics of Multicarrier signals, Bit and Power allocation in Multicarrier modulation, Peak to Average ratio in multicarrier modulation, Channel coding considerations in Multicarrier modulation. An Overview of multi-carrier CDMA .	
		TOTAL	**52**

Reference Books :-

1. Alberto-Leon Garcia, "Probability and Random Processes for Electrical Engineering", Pearson Education

2. Simon Haykin, "Digital Communication Systems", Wiley 2014

3. Bernard Sklar, " Digital Communications: Fundamentals & Applications", Pearson Education 2nd Ed.

4. Dr. Kamilo Feher , "Wireless Digital Communication", Prentice Hall Publication

5. John G Proakis, Masoud Salehi , "Communication Systems Engineering", Pearson Education , 2nd Ed.

6. John Proakis & Masoud Salehi , "Digital Communication", McGraw-Hill Education, 5th Ed

7. Simon Haykin "Adaptive Filter Theory", Prentice Hall Publication 4th Ed.

Research Publications :-

1. Andrew J. Viterbi, "Convolutional codes and their performance in communication systems", IEEE Transactions on Communications Technology, October 1971 , Pages 751 - 772

2. Y. Sato, "A Method of Self-Recovering Equalization for Multilevel Amplitude-Modulation Systems", IEEE Transactions on Communications   June 1975,vol:23,Issue: 6, Page(s): 679 - 682

3. Seung Hee Han & Jae Hong Lee, "An Overview of Peak-To-Average Power Ratio Reduction Techniques for Multi Carrier Transmission", IEEE Wireless Communications Journal, April 2005, Pages : 56-65, vol:12 Issue:2

4. R. Prasad & S .Hara, "An overview of multi-carrier CDMA" , Proc. of IEEE 4th International Symposium on Spread Spectrum Techniques and Applications Publication Year: 1996, Page(s):107-114, vol.1

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1012	Mixed Signal VLSI Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1012	Mixed Signal VLSI Design	20	20	20	80	---	---	---	100

Course Pre-requisites:-
1. VLSI Design
2. IC Technology
3. CMOS VLSI Design

Course Objectives:-
1. To make students understand & appreciate analytical approach for design of analog VLSI Design
2. To make students ready for design of coexistence of analog and digital circuit and the system level issues

Course Outcomes:-
1. Tackle with the system level issues for mixed VLSI design
2. Explain working of certain basic analog building blocks
3. Design different data converters
4. Implement and comment on performance of Memory devices.
5. State the significance of PLL in mixed VLSI design.

Module No.	Unit No.	Topics	Hrs.
01		Analog and discrete-time signal processing	**06**
		Mixed-Signal Layout Issues, *Floor-planning, Power Supply and Grounding Issues, Guard Rings*	
02		Analog integrated continuous-time and discrete-time filters	**10**
		MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator, Analog multipliers, Loop Filters, Switched Capacitor filter	
03		Special-purpose CMOS circuits.	**08**
		Schmitt trigger, Multi-vibrator Circuits, Ring oscillators, VCO , Voltage Generators	
04		Data Converters	**10**
		Basics of Analog to digital converters (ADC) Basics of Digital to analog converters (DAC) DACs Successive approximation ADCs Dual slope ADCs High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures) High-resolution ADCs (e.g. delta-sigma converters)	
05		Memory	**08**
		ROM, EPROM, F-N model, RAM Memory structure Array Design, sensing and operation of memory cell.	
06		Phase Lock Loop	**10**
		Mixed-Signal layout Interconnects Phase locked loops Delay locked loops. Simple PLL, Charge pump PLL, Non ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
TOTAL			**52**

Reference Books:-

1. CMOS mixed-signal circuit design by R. Jacob Baker, Wiley India, IEEE press, reprint 2008.
2. Design of analog CMOS integrated circuits by Behzad Razavi, McGraw-Hill, 2003.
3. CMOS circuit design, layout and simulation by R. Jacob Baker, Revised second edition, IEEE press, 2008.
4. CMOS Integrated ADCs and DACs by Rudy V. dePlassche, Springer, Indian edition, 2005.
5. Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1981.
6. Design of analog filters by R. Schauman, Prentice-Hall 1990 (or newer additions)
7. An introduction to mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 2008.

Research Publication:-

1. Lanny L. Lewyn, Trond Ytterda, Carsten Wulff, and Kenneth Martin, "Analog circuit Design in Nanoscale Technologies", Proceedings of the IEEE Vol.97, No.10, October 2009
2. Chi-Sheng Lin, Bin-Da Liu, "A new successive approximation architecture for low-power low-cost CMOS A/D converter," IEEE Journal of Solid State Circuits, Vol.30, Issue. 1, Pages:54-62, 2003.

Internal Assessment (IA) :-
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1013	Power Electronics System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXC1013	Power Electronics System Design	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Single phase & three phase AC fundamentals
2. Basic understanding of power electronic devices like SCR, IGBT etc. & commutation techniques
3. Basic working of controlled DC-DC, DC-AC & AC-DC converters, PWM technique for control

Course Objectives:-

1. To make students understand & appreciate analytical approach for design of power electronic systems
2. To make students ready for research & development oriented jobs in academia & industry by introducing recent research advancements in power electronic converters & their applications in distributed generation & smart grids

Course Outcomes:-

1. Ability to apply mathematical modeling concepts to power electronic systems
2. Ability to understand unique nature of computer simulations of power electronic systems
3. Ability to understand new topologies of DC-AC inverters like multi-level & 4-leg inverters
4. Ability to gain in-depth knowledge of AC voltage controllers
5. Ability to understand various issues involved in parallel operation of inverters as part of the distributed generation system
6. Be aware of vital role played by power electronic converters in distributed generation & smart grids

Module No.	Detailed contents	Hours
1	**Analysis of Power Devices** Power transistor, Power MOSFET, SCR, IGBT, design of driver circuits for SCR, BJT, IGBT, MOSFET, selection criteria for switching devices, EMI-EMC issues, protection circuits: Anti saturation protection for BJT and IGBT, overload protection, thermal protection.	06
2	**Simulation of Power Electronic Converters and Systems** Brief overview of solving stiff differential equations using ODE solvers like Euler's method, Heun's Method, Trapeziodal rule, introduction to circuit oriented simulators like SPICE, MATLAB, SCILAB, comparison of these simulators, study of transformations from 3-phase to stationary reference frame (Clarke transform) and rotating reference frame, decoupled closed-loop control strategies for converters based on these transformations.	10
3	**Modeling and Control of Power Electronic Systems** Concept of zero-order hold (ZOH), first-order hold (FOH) and second-order hold (SOH) elements, energy factor, models of AC-DC, DC-AC, AC-AC and DC-DC converters as simple ZOH, FOH and SOH, PI control for AC-DC converters, PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis.	08
4	**Inverters (DC-AC Converters)** Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques), neutral point clamped inverter, study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters: droop, and master & slave control.	10
5	**AC Voltage Controllers** On-Off control, phase control, single-phase full wave analysis with R & R-L load, input power factor, three-phase full wave controller with R-load, static switches.	08
6	**Grid Interface of Renewable Energy Sources** Inverter interfacing control strategies for transferring wind and solar energy to grid, instantaneous power theory, reactive power control, synchronization with grid using phase-locked loop, concept of distributed generation system, microgrids, smart grids.	10
	TOTAL	52

Reference Books :-

1. N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.

2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.

3. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer USA, 2001.

4. F. L. Luo, H. Ye, M. H. Rashid, Digital Power Electronics & Applications, Elsevier Academic Press, USA, 2005.

5. H. Akagi, E. H. Watanabe, M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press/John Wiley & Sons Ltd., USA, 2007.

6. Q.-C. Zhong, T. Hornik, Control of Power Inverters in Renewable Energy And Smart Grid Integration, IEEE Press/John Wiley & Sons, Ltd., USA, 2013.

Research Publications :-

1. J.-S. Lai & F. Z. Peng, Multilevel converters – A new breed of power converters, IEEE Transactions on Industry Applications, vol. 32, no. 3, pp. 509-517, May/Jun 1996.

2. T. Kawabata and S. Higashino, Parallel operation of voltage source inverters, IEEE Transactions on Industry Applications, vol. 24, no. 2, pp. 281–287, 1988.

3. W. C. Lee, T. K. Lee, S. H. Lee, K. H. Kim, D. S. Hyun, and I. Y. Suh, A master and slave control strategy for parallel operation of three-phase UPS systems with different ratings, Proceedings of the 19th Annual IEEE Applied Power Electronics Conference & Exposition, (Anaheim, California, USA), pp. 456–462, Feb. 2004.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1011	Advanced Processor Architectures-I	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1011	Advanced Processor Architectures-I	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Organization

Course Objectives:-

1. To outline the various factors that contributes to processor performance.
2. To understand the hardware & software enhancements that lead to improved computing experience.
3. To elaborate on the importance of parallelism in processor systems.
4. To analyze issues that present constraints to increasing processor power.

Course Outcomes:-

1. Explain the protection mechanism employed in advanced processors.
2. Describe various enhancements in advanced processor architectures leading to high performance
3. Analyze the complexities in pipeline design
4. Describe issues dealing with parallelism in computing systems.

Module No.	Unit No.	Topics	Hrs
1		**Performance Metrics**	04
	1.1	Processor performance equation	
	1.2	Energy and power within a microprocessor and power-reduction techniques	
	1.3	Designing for increasing performance of a Computer	
	1.4	Trends in Cost, Dependability, Benchmarking	
2		**X86 Protection Mechanism**	12
	2.1	Protected mode register set	
	2.2	Segmentation in protected mode, Segment Descriptors	
	2.3	Virtual memory management, Address Translation	
	2.4	Privilege levels, Protection rules, Gate descriptors	
	2.5	Multi-tasking and task switching mechanisms	
	2.6	Paging	
3		**Architectural Enhancements**	12
	3.1	CISC and RISC processors	
	3.2	Pipelined processors	
	3.3	Superscalar Architectures	
	3.4	Out-of-Order Execution	
	3.5	VLIW processors	
	3.6	Super-pipelining, Branch Prediction logic	
4		**Case Study on the Pentium processor**	08
	4.1	Architecture	
	4.2	Register Organization	
	4.3	Instruction pairing, Split-line access mechanism	
	4.4	Branch Prediction logic	
	4.5	On-chip cache organizations, Write-Once policy, Cache coherence	
5		**Pipelining concepts**	08
	5.1	Pipeline performance	
	5.2	Arithmetic pipelines	
	5.3	Hazards, Detection logic and minimization techniques	
	5.4	Dynamic Instruction scheduling	
	5.5	Pipeline scheduling theory	
6		**Parallelism**	08
	6.1	Amdahl's law	
	6.2	Instruction-level parallelism (ILP), Thread-level parallelism (TLP)	
	6.3	Symmetric multi-processors(SMP),Multi-threading	
	6.4	Multi-processor Organizations, Multi-core processors (CMP)	
	6.5	Clusters, Non-Uniform memory access (NUMA)	
	6.6	Vector Computation, Graphic processing units(GPU)	
		TOTAL	52

Reference Books :-

1. J.L. Hennessy, and D.A. Patterson, Computer Architecture: A quantitative approach, Fifth Edition, Morgan Kaufman Publication, 2012.

2. Walter A. Triebel, The 80386DX Microprocessor, Prentice-Hall International Editions.

3. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition, Pearson Publications.

4. Don Anderson, Tom Shanley, Pentium Processor System Architecture, Second Edition, Mindshare Inc.

5. M.R. Bhujade, Parallel Computing, Second Edition, New-Age International.

6. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.

Research Publications :-

1. M.D. Hill, Michael Marty, "Amdahl's Law in the Multi-core era", Computer, Volume 41, Issue 7, 2008, ISSN :0018-9162 , Pgs. 33-38.

2. J.L. Hennessy, " VLSI Processor Architecture", IEEE Transactions on Computers ,Volume C-33, Issue:12 Pgs. 1221-1246.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1012	Network & System Administration	04	---	---	04	---	---	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1012	Network & System Administration	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Communication Networks

Course Objectives:-

1. To create ability for designing, administrating small & medium networks
2. To create ability for automating system administration tasks

Course Outcomes:-

1. Ability to manage users, files & software on computer system installation consisting of clients & servers
2. Ability to install & configure networking services for intranet & internet domains
3. Ability to administer network security policies in LINUX
4. Ability to design small & medium size IT infrastructure organization
5. Ability to develop scripting mechanisms & automated scripts to perform complicated administration tasks
6. Ability to deploy systems to manage large amounts of data for wide variety of users

Module No.	Topics	Hrs.
1	**Foundation Elements** Hardware components, capacity planning, namespaces, data integrity, policies and ethics	08
2	**Service Provisioning** Domain name services, collaborative communication, backups and restoration, remote access, remote deployment, web services	10
3	**Network Security** Organizational profile, SMA segment, large company e-commerce web sites, large universities, case studies based on above	08
4	**System Scripting** Shell scripting, BASH, CSH, python scripting for system administration, PHP scripting for web interfaces	12
5	**Data Centers** Locational preferences, security concerns in physical and remote access, power and temperature concerns, tools, supplies and SLA	08
6	**Case Studies** Case studies based on capacity planning and data centers	06
	TOTAL	52

Reference Books :-

1. The practice of System and Network Administration (2nd Edition), Thomas A Limoncelli, Christina J Hogan, and Strata R Chalup, Addison Wesley, ISBN 0-321-49266-8

2. Unix and Linux System Administration Handbook (4th Edition), Evi Nemeth, Garth Snyder, Trent R Hein, Ben Whaley, Prentice Hall, 2011, ISBN: 10: 0-13-148005-7

3. Essential System Administration (3rd Edition), A Frisch, O'Reilly, 2002, ISBN: 10: 0-596-00342-9

4. Linux Administration - A Beginners Guide, (6th Edition), Wale Sayinka, McGraw Hill, 2012, ISBN: 10:0-07-176758-4

5. TCP/IP Network Administration (3rd Edition) C Hunt, O'Reilly, 2002, ISBN: 10: 0-596-00297-1

6. Learning Python, 5th Edition Mark Lutz,O'Reilly,ISBN-13: 978-1449355739

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.
End Semester Examination :-
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1013	Modeling of Microelectronics Devices	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1013	Modeling of Microelectronics Devices	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Electronic devices: Operation and Characteristics

Course Objectives:-

1. To learn & apply basic concepts of semiconductor physics relevant to electronic devices
2. To analyze & explain operation of semiconductor devices in terms of their physical structure
3. To estimate various device parameters & their measurement
4. To describe & use the device & circuit models of semiconductor devices of varying level of complexity

Course Outcomes:-

1. Ability to apply & explain basic semiconductor concepts applicable to the devices
2. Ability to describe the underlying physics & principles of operation of various devices
3. Ability to create & apply linear incremental equivalent circuit models for BJT & MOSFET
4. Ability to determine parameter values for large signal & incremental linear equivalent circuit models for the p-n diodes, BJT & MOSFET based on knowledge of device structure, dimensions & bias conditions

Module No.	Unit No.	Topics	Hrs.
1		**Basic Semiconductor Physics**	**10**
	1.1	Review of quantum mechanics,	
	1.2	Electrons in periodic lattices, Ek diagrams, Quasi-particles in semiconductors, electrons, holes and phonons	
	1.3	Boltzmann transport equation and solution in the presence of low electric and magnetic fields - mobility and diffusivity	
	1.4	Carrier statistics; Continuity equation, Poisson's equation and their solution; High field effects: velocity saturation, hot carriers and avalanche breakdown	
2		**Semiconductor Junction**	**10**
	2.1	p-n junction action, Abrupt junction, Linearly graded junction, Static IV Characteristics of p-n junction, Electrical breakdown in p-n junctions	
	2.2	Dynamic behaviour of p-n junction diode	
	2.3	Majority carrier diodes	
	2.4	Schottky, homo- and hetero-junction band diagrams and I-V characteristics	
	2.5	Small signal switching models;	
	2.6	Two terminal and surface states devices based on semiconductor junctions.	
3		**Modeling Bipolar Device Phenomena**	**08**
	3.1	Injection and Transport Model	
	3.2	Continuity Equation	
	3.3	Transistor Models: Ebers - Moll and Gummel Poon Model	
	3.4	SPICE modeling, temperature and area effects	
4		**MOSFET Modeling**	**10**
	4.1	Introduction, Inversion Layer,	
	4.2	Threshold Voltage	
	4.3	Gradual Channel Approximation, MOS Transistor Current	
	4.4	Temperature, Short channel and Narrow Width Effect	
	4.5	Characterization of MOS capacitors: HF and LF CVs	
	4.6	Models for Enhancement, Depletion Type MOSFET	
	4.7	CMOS Models in SPICE	
	4.8	Quasi-static compact models of MOS transistors;	
	4.9	Measurement of MOS transistor parameters	
5		**Modeling of Hetero Junction Devices**	**08**
	5.1	Band gap Engineering	
	5.2	Band gap Offset at abrupt Hetero-junction	
	5.3	Modified current continuity equations	
	5.4	Hetero Junction bipolar transistors (HBTs), Si-Ge	
6		**Monte Carlo Particle Modeling of Semiconductor Devices**	**06**
	6.1	The Monte Carlo method	
	6.2	Application of Monte Carlo techniques to device modeling	
		TOTAL	**52**

Reference Books :-

1. M. S. Tyagi, "Introduction to Semiconductor Materials and Device", John Wiley & sons, 1991

2. Ben G. Streetman & S. K. Bannerjee, "Solid State Electronic Devices" 6th edition, Prentice Hall

3. Richard S. Muller & Theodore I. Kummins, "Device Electronics for Integrated Circuits", John Wiley & Sons, 2nd edition (1986)

4. A. S. Grove, "Physics & Technology for Semiconductor Devices", McGraw Hill, 3rd edition (2007)

5. Donald A. Neamen, "Semiconductor Devices & Physics", McGraw Hill, 3rd edition (2007)

6. M. H. Rashid, "SPICE for Circuits & Electronics", Prentice Hall (1995)

7. A. Vladimirescu, "The SPICE Book", John Wiley & Sons, New York (1994)

Research Publications :-

1. Christopher M. Snowden, "Semiconductor Device Modeling" Rep. Prog. Phys. Vol. 48, pp. 223-275

2. C. Moglestue, 'Monte Carlo particle modeling of small semiconductor devices" Computer Methods in Applied Mechanics & Engineering Vol. 30 (1982) pp. 173-208; North – Holland Publishing

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Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1014	Modeling & Simulation	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks							
		Internal Assessment			End Sem Exam	Term Work	Practical	Oral	Total
		Test 1	Test 2	Average					
ELXDLO1014	Modeling & Simulation	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Laplace & Inverse Laplace Transform with their properties
2. Z-transform & Inverse Z-transform with their properties
3. Fourier & Inverse Fourier Transform with their properties
4. Concept of transfer function
5. Fundamentals of linear ordinary differential equations (ODEs)

Course Objectives:-

1. To present concepts of modeling & simulation applicable to various domains of engineering & science
2. To provide theoretical concepts, methods & simulation
3. To gain solid foundation & associated experience for constructing, simulating & analyzing models

Course Outcomes:-

1. Ability to model deterministic systems and differentiate between nonlinear and linear models
2. Ability to understand and appreciate the modeling of distributed parameter systems
3. Ability to understand the definition of simulation & how to develop & analyze simulation model
4. Ability to numerically simulate ordinary differential equations and deterministic systems
5. Ability to correctly design, analyze and interpret the results using simulation

Module	Topic	Hrs.
1	**Introduction to Philosophy of Modeling** Concept of system; Classification of Systems: Linear Systems, Time-Varying vs. Time-Invariant Systems, Lumped vs. Distributed Parameter Systems, Continuous- and Discrete-Time Systems, Deterministic vs. Stochastic Systems, Hard and Soft Systems; Analysis of Systems; Large and Complex Applied System Engineering: A Generic Modeling; Necessity of System Modeling; Characteristics of Models; Trade-offs involved in modeling process; model benchmarking and validation; brief introduction to different types of Modeling methods: First principles, data-driven models, static and dynamic modeling, Linear Regression, Least Squares Method.	08
2	**First Principles Modeling of Deterministic Systems** Lumped parameter modeling using ordinary differential equations; physical understanding of initial conditions and their effects on system response; natural and forced response, transfer functions; stability; dynamic properties using transfer function approach; State space models; Solution of State Equations; Controllability; Observability, examples of systems RLC circuits; Modeling of diodes and transistors; Modeling of power electronics circuits; Mechanical systems: Translational and rotational; electromechanical systems.	10
3	**Data Driven Modeling of Deterministic Systems** System as a black box; comparison between first principles and data-driven modeling; necessity for data-driven modeling; time-domain identification of linear systems; concept of difference equation and discrete transfer function; sampling time; various excitation signals like impulse, step, ramp, sinusoidal, pseudo-random binary signal, their statistical properties; concept of persistently exciting signals, de-trended data; various methods/structures of system identification: ARX, ARMAX, and output error, least-squares method, model validation, frequency-domain identification using Bode plot, application of these techniques to simple RLC and mechanical systems.	10
4	**Modeling of Distributed Parameter Systems** Examples of distributed parameter systems: heat conduction, turbulence, diffusion, transport in semiconductors, polymers; concept of infinite-dimensional systems; introduction to linear partial differential equations (PDEs); initial boundary value problem (IBVP); solution using separation of variables method for simple diffusion and other processes with simple geometry; finite difference method for numerical solution of PDEs; concept of multiphysics systems, necessity for multiphysics modeling, examples, introduction to various multiphysics simulation tools.	10
5	**Simulation of Physical Systems** Introduction; need for simulation; difference between simulation and emulation; Advantages of Simulation; When to Use Simulations; How Simulations Improve Analysis and Decision Making; Applications of Simulation; Numerical Methods for Simulation; The Characteristics of Numerical Methods; Comparison of Different Numerical Methods; Errors during Simulation Numerical Methods, introduction to different type of simulation software.	08
6	**Verification & Validation of Simulation Models & Optimization** Model building, verification and validation; concept of model benchmarking; Verification of simulation models; Calibration and validation of models; difference between the best model and the feasible model; various optimization techniques used for Simulation and model validation.	06
	TOTAL	**52**

Reference Books :-

1. D. K. Chaturvedi, Modeling and Simulation of Systems using Matlab / Simulink, CRC Press, USA, 2009.

2. D. G. Luenberger, Introduction to Dynamic Systems: Theory, Models, & Applications, First Edition, John Wiley & Sons, USA, 1979.

3. R. L. Burden and J. D. Faires, Numerical Analysis, 9th Edition, Cengage Learning, 1993.

4. J. Lewis, Modeling Engineering Systems: PC-Based Techniques and Design Tools (Engineering Mentor Series), Surber Press, USA.

5. Y. W. Kwon, Multiphysics and Multiscale Modeling: Techniques & Applications, CRC Press, USA, 1996

6. L. Ljung, System Identification: Theory for the User, Prentice Hall, USA, 1999.

Research Publications :-

1. Report by Argonne National Laboratory (Mathematics & Computer Science Division), USA, Multiphysics Simulations: Challenges and opportunities, 2012.

2. S. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, USA, 1993

3. L. Ljung, Perspectives on system identification, Annual Review in Control (ScienceDirect) Vol. 34, Issue 1, pp. 1-12 (2010)

4. T. Lingefaard, Faces of mathematical modeling, Zentralblatt für Didaktik der Mathematik (ZDM) – Mathematics Education, Vol. 38, Issue 2, pp. 96-112, April 2006.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1015	Advanced Digital Image Processing	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO1015	Advanced Digital Image Processing	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Digital Image Processing

Course Objectives:-

1. To understand the principles of advanced digital image processing
2. To understand the concepts of latest image compression standards
3. To study advanced techniques of image classification & restoration
4. To learn & appreciate image reconstruction & computer tomography (CT)
5. To acquire working knowledge in the field of remote sensing & steganography

Course Outcomes:-
1. Ability to understand & appreciate latest image compression standards for still & video images
2. Ability to gain adequate knowledge of image classification techniques
3. Ability to understand working principles of several important applications of digital image processing
4. Ability to interpret & analyze information from remote sensed images

Module No.	Unit No.	Topics	Hrs.
1		**Image Compression Techniques**	**10**
	1.1	Compression based on DCT and Wavelet transform	
	1.2	JPEG 2000 and video compression standards	
2		**Image Classification techniques**	**10**
	2.1	Patterns and pattern classes	
	2.2	Minimum distance classifier	
	2.3	Optimum statistical Bayes classifier for Gaussian pattern classes	
3		**Image Restoration**	**08**
	3.1	Image degradation models, Noise models	
	3.2	Noise probability density functions	
	3.3	Estimation of noise parameters	
	3.4	Inverse filter and Wiener filter	
4		**Image Reconstruction**	**10**
	4.1	Image reconstruction from projections	
	4.2	Principle of computer tomography	
	4.3	Radon transform and Fourier slice theorem	
	4.4	Reconstruction using parallel beam filtered back propagation	
5		**Introduction to remote sensing, information extraction from remote sensing images**	**08**
	5.1	Characteristics of Multispectral Scanner System (MSS)	
	5.2	Image centered and data centered information extraction	
	5.3	Spectral factors in remote sensing	
	5.4	Spectral signatures	
	5.5	Types of remote sensing systems and scanners	
6		**Applications of Image Processing**	**06**
	6.1	Image Fusion	
	6.2	Steganography	
		TOTAL	**52**

Reference Books :-

1. Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education

2. Robert Schowengerdt, "Remote sensing modules and methods for Image processing" Elsevier

3. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 2007

4. Milan Sonka, Vaclav Hlavac & Roger Boyle, "Image Processing, Analysis, Machine Vision", 3rd edition, Brooks Cole

Research Publications :-

1. A. J. Roses, W. K. Pratt, G. S. Robinson "Interframe cosine transform image coding" IEEE Transactions on Communications, vol. COM-25, Nov. 1977, pp. 1329-1339.

2. Valdimir S. Petrovic Costas S. Xydeas, Gradient-Based Multiresolution Image Fusion, IEEE Transactions on Image Processing, Vol. 13, No. 2, February 2004, pp. 228-237

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO1011	**Product Life Cycle Management**	**03**

Objectives:
1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…
1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction	05

	of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO1012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO1013	**Management Information System**	**03**

Objectives:
1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO1014	**Design of Experiments**	**03**

Objectives:
1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…
1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The 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 and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07

06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
   1. Question paper will comprise of total six question
   2. All question carry equal marks
   3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
   4. Only Four question need to be solved.

REFERENCES:

   1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
   2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
   3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
   4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
   5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
   6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGrawHill
   7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.		05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,		05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO1016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO1017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management.	06

		Applications of GIS, Remote sensing and GPS in this regard.	
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.		09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.		06

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.
(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILOS 1018	**Energy Audit and Management**	**03**

Objectives:
1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…
1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**
 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

Suggested List of Experiments (Any six) :-

1. Generating and processing of random signals
2. Simulation of communication systems with AWGN channels (BER)
3. Introduction to Monte-Carlo methods
4. Multipath fading channels – simulation of Raleigh and Ricean Channels
5. Simulation of CDMA system.
6. Simulation of OFDM system.
7. Equalizers – Simulation of LMS algorithm
8. Simulation Viterbi decoding algorithm
9. Simulation of Turbo Encoder and Decoder
10. Simulation of LDPC Encoder.

Course Code	Course Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL1012	Mixed Signal VLSI Design Laboratory – II	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXL1012	Mixed Signal VLSI Design Laboratory – II	---	---	---	---	25	---	25	50

Suggested List of Experiments (Any six) :-

Students will have to perform at least one experiment on each module and submit certified journal having a minimum of 8 experiments.

Module No.	List of Experiments
1	Supply and ground bounce determination
2	Switch capacitor Filter Analog Multiplier
3	Schmitt Trigger Ring oscillator
4	ADC based on charge distribution Delta-sigma converters
5	ROM Implementation Sensing amplifier Operation of Memory cell
6	PLL Implementation DLL Implementation

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

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2023	Advanced Signal 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					
ELXC2023	Advanced Signal Processing	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Signals & Systems
2. Digital Signal Processing
3. Probability & Random Processes

Course Objectives :-

1. To understand DSP techniques in different fields of modern-day applications
2. To study multi-rate DSP algorithms & filter bank analysis for real world applications
3. To develop a solid foundation in linear prediction analysis & optimum filtering concepts
4. To learn thoroughly RMS & LMS algorithm which are at the heart of adaptive systems
5. To gain deep insight into spectrum estimation algorithms

Course Outcomes:-

1. Ability to apply multi-rate processing techniques in practical applications
2. Ability to design optimum filters suited for different applications
3. Ability to design & simulate adaptive systems
4. Ability to extract information from spectral analysis of signals
5. Ability to design & test signal processing algorithms for various tasks

Module No.	Unit No.	Topics	Hrs.
01		**Introduction and Review**	**04**
	1.1	Basic DSP examples in block diagrams, Typical DSP in real world applications.	02
	1.2	Review of FIR & IIR filters, Sampling and Reconstruction of signals, Analog to digital and Digital to analog conversions.	02
02		**Multirate Digital Signal Processing**	**12**
	2.1	Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D .	03
	2.2	Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion.	03
	2.3	Sampling rate conversion of band pass signal, sampling rate conversion by arbitrary factor, Applications of multirate signal processing.	03
	2.4	Digital filter banks, Two channel Quadrature Mirror filter banks.	03
03		**Linear Prediction and Optimum filters**	**12**
	3.1	Random signals, Correlation functions, Power Spectra, Innovations representation of a Stationary random Process	03
	3.2	Forward and Backward Linear predictions.	03
	3.3	Solution of Normal equations. The Levinson-Durbin Algorithm, The Schur Algorithm. Properties of the Linear Prediction Error Filters.	03
	3.4	AR lattice and ARMA Lattice Ladder filters. Wiener filters for filtering and Prediction	03
04		**Adaptive Digital Filters**	**10**
	4.1	FIR adaptive filters, Steepest descent adaptive filter, LMS algorithms, Normalized LMS, Application in noise cancellation.	04
	4.2	Adaptive Recursive filters.	04
	4.3	Recursive Least squares algorithms.	02
05		**Power Spectrum Estimation**	**08**
	5.1	Estimation of spectra from finite duration observations of signals.	02
	5.2	Nonparametric methods for power spectrum estimation.	02
	5.3	Parametric methods for power spectrum estimation.	04
06		**Applications of DSP**	**06**
	6.1	Biomedical applications, ECG signal analysis, QRS template, QRS detection methods etc.	03
	6.2	Speech processing applications, Wideband and narrowband spectrograms.	03
		TOTAL	**52**

Reference Books :-

1. Digital Signal Processing Principles, algorithms & applications, John. G. Proakis, D.G.Manolakis. 4/e

2. Digital Signal Processing, "A Practical approach", Emmanuel C Ifeachor & B.W.Jervis. Pearson

3. Digital Signal Processing. A computer based approach, S.K.Mitra, Tata Mc Graw Hill

4. Statistical Digital Signal Processing, Monson. H .Hayes, Wiley India

5. Introduction to Digital Speech Processing, L.R. Rabiner & R.W Schafer, Pearson

6. Discrete time Signals Processing, Oppenheim & Schaffer, Pearson

Research Publications :-

1. P. Vaidyanathan (1990) . "Multirate Digital filters, Filter banks, Polyphase network and applications: A tutorial"   Proc. IEEE vol 78, No 1,pp 56-90.

2. Schoeder M.R (1985)   "Linear predictive coding of speech: Review and current directions" IEEE Communication Magazine vol. 23, pp. 54-61

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2021	Advanced Computer Architectures-II	04	---	---	04	---	---	04

Subject Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2021	Advanced System Architectures-II	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Organization & Processor Architectures

Course Objectives:-

1. To outline the various factors those contribute to system design
2. To understand the design flow of application specific processors
3. To elaborate on the importance of VLIWDSP processors & soft-core processors
4. To analyze issues & pitfalls in reconfigurable processor design with FPGA

Course Outcomes:-

1. Ability to explain various types of processors & their design flow in detail
2. Ability to describe various concepts of VLIWDSP processors & soft-core processors
3. Ability to analyze the issues in VLIWDSP processor design
4. Ability to describe pitfalls in designing with reconfigurable processors with FP

Module No.	Unit No.	Topics	Hrs.
1		**Computer Architecture Fundamentals**	**06**
	1.1	A top Level View of Computer functions and Interconnections	
	1.2	Computer Components, Architecture organization	
	1.3	Concepts and Ways of Parallelism	
	1.4	Domain-Specific Processors and Application Specific Processors	
	1.5	Design Considerations	
2		**Processor Design Flow**	**08**
	2.1	Capturing requirements, Instruction coding	
	2.2	Exploration of Architecture Organizations	
	2.3	Hardware and Software Development	
	2.4	Software tools and libraries	
3		**Memory**	**06**
	3.1	Semiconductor Memories SRAM, DRAM and organization	
	3.2	Principles of Cache memory, Cache Design	
	3.3	Cache Coherency, MESI Protocol	
	3.4	RAID	
4		**I/O, Peripherals and Operating System**	**08**
	4.1	Types of I/Os, I/O Interfacing concepts	
	4.2	PCI, PCI-X, PCI-E	
	4.3	Universal Serial Bus(USB)	
	4.4	Operating System Overview, Scheduling	
	4.5	Memory Management in Operating Systems	
5		**VLIW DSP Processor**	**12**
	5.1	DSP Processor Architecture, DSP-specific requirements	
	5.2	Micro architectural concepts	
	5.3	VLIW and SW programmability	
	5.4	Application specific adaptable core Architecture	
	5.5	Design space Exploration, Complexity of Configurability	
6		**Soft-Core Processors**	**12**
	6.1	Processor Customization	
	6.2	Microprocessor cores in SOC design, Difference between Microprocessor and SOC	
	6.3	Reconfigurable processors with FPGA	
	6.4	Case study of Reconfigurable structure	
	6.5	Pitfalls in VLIW Architectures	
		TOTAL	**52**

Reference Books :-

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Eighth Edition, Pearson Publications.

2. Jari Nurmi, "Processor Design: System-on-Chip Computing for ASICs and FPGAs", Springer.

3. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.

4. Hennessy JL, Patterson DA (2003) Computer Architecture: A Quantitative Approach.3rd edition. Elsevier Morgan Kaufmann, San Francisco

Research Publications :-

1. Andrea Lodi, Mario Toma, "A VLIW Processor with a Reconfigurable Instruction Set for Embedded Applications", IEEE Journal Of Solid-State Circuits, Vol. 38, No. 11, November 2003,pp-1876-1886.

2. Lodi A, Cappelli A, Bocchi M, Mucci C, "XiSystem: A XiRisc-based SoC with a Reconfigurable I/O Module", IEEE Journal of Solid-State Circuits (JSSC), 2006, Vol.41, No.1, pp-85–96.

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2022	Wireless & Mobile Networking	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2022	Wireless & Mobile Networking	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. Computer Communication Networks

Course Objectives:-

1. To understand the various aspects of Wireless network operation
2. To understand the concept of Ad Hoc Networks
3. To comprehend the usefulness of Wireless Sensor Networks in many applications
4. To understand and analyze various Protocols of MANETS and WSNs.

Course Outcomes:-

1. Students would be able to understand principle of operation of Wireless Networks & its salient features.
2. Students would be the able to comprehend the various issues involved in establishing Mobile Ad Hoc Networks, designing its MAC Protocols.
3. They will have the ability to analyze and compare various Routing Protocols of MANETs.
4. They will have the ability to understand the significance of wireless Sensor Networks and its widespread applications all around us.
5. Students would be exposed to research issues in Next-Generation networks - Cognitive Radio Networks.

Module No.	Unit No	Topics	Hrs
01		**Review of Wireless network operation & Wireless LANs**	08
	1.1	Wireless Network operation: topologies: Infrastructure networks and Adhoc networks, Mobility Management – Mobile IP operation of Mobile IP, Discovery, Registration, and Tunneling.	
	1.2	Power control & Power saving Mechanisms in Wireless networks, Energy efficient designs and Energy efficient software approaches	
	1.3	Overview of Wireless LAN: 802.11 Architecture, Medium Access Control: CSMA /CA , DCF , PCF , MAC Frame	
02		**Mobile ADHOC Networks (MANETs)**	08
	2.1	Ad hoc wireless networks: Issues in Ad Hoc wireless networks, Issues in designing MAC Protocol for Ad Hoc networks, Classification of MAC protocols	
	2.2	Contention-based Protocols: Contention-based Protocols with reservation mechanisms, Contention-based MAC Protocol with Scheduling mechanisms	
03		**ROUTING PROTOCOLS for Mobile ADHOC Networks**	12
	3.1	Routing Protocols for MANETs : Classification of Routing Protocols, Table –driven Routing Protocols: Distance Sequence Distance Vector Routing protocol, Cluster-head Gateway switch routing protocol, On-demand Routing protocols: Dynamic Source Routing Protocol , Ad Hoc On-demand Routing protocols (AODV), Hierarchical Routing Protocols and Power aware Routing protocols	
	3.2	Multicast Routing in MANETs: introduction and Classification of Multicast routing protocols	
	3.3	Transport Layer protocol for MANETs: TCP over Ad Hoc wireless networks : issues and challenges ,QOS in MANETS: issues and challenges	
04		**Introduction to Wireless sensor networks**	08
	4.1	Introduction and overview of WSN: Sensor Network Architectural Elements, Basic Wireless sensor technology: Sensor node technology,	
	4.2	Applications of WSN: Category 1 WSNs and Category 2 WSNs Challenges and hurdles in WSN.	
	4.3	Data Gathering ,MAC Protocols for WSN: Schedule based protocols , Random- Access based protocols	
05		**Routing protocols for Wireless sensor networks**	10
	5.1	Routing Challenges and Design issues in WSN ,Data Dissemination, Routing strategies in WSN : Proactive , Reactive hybrid strategies	
	5.2	Data centric Routing Protocol: SPIN	
	5.3	Hierarchical Routing protocol : LEACH	
06		**Recent Advances in Wireless networks**	06
	6.1	Cognitive Radio Networks : Spectral sensing , white holes, Spectrum management	
	6.2	Open Research Issues in Multi-hop Cognitive Radio Networks	
		TOTAL	52

Reference Books :-

1. Kaveh Pahlavan, "Principles of Wireless Networks: A Unified Approach", Pearson Education

2. William Stallings,"Wireless Communications & Networking", 2nd Ed., Pearson Education

3. Siva Ram Murthy & B.S.Manoj, "Ad hoc wireless Networks: Architectures and Protocols "Pearson

4. Sohraby Kazem, Minoli Daniel & Znati Taieb,"Wireless Sensor Networks: Technology, Protocols and Applications", WILEY student Edition

5. Zhao Feng & Guibas Leonidas,"Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann

Research Publications :-

1. Ian F. Akyildiz . Et al. ,"Wireless sensor networks: a survey", Elsevier Journal of Computer Networks 38 (2002) 393–422

2. Kemal Akkaya & Mohamed Younis , "A survey on routing protocols for wireless sensor network" , Elsevier Journal of Ad Hoc Networks 3 (2005) 325–349

3. A. Ghasemi and E. S. Sousa, "Spectrum sensing in cognitive radio networks: Requirements, challenges and design trade-offs," IEEE Communications Magazine, vol. 46, no. 4, pp. 32-39, April 2008.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme (Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO2023	Nanoelectronics	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXDLO2023	Nanoelectronics	20	20	20	80	---	---	---	100

Course Pre-requisites:-

1. MOSFET & Microelectronic Concepts
2. Quantum Mechanics

Course Objectives:-

1. To learn fundamental concepts of nanoelectronics including single electron effects & electron transport in nanoscopic system
2. To learn the concept of the quantum dot, the quantum wire, quantum well & nano applications of these structures
3. To gain knowledge on SET & carbon nano tubes in design of transistors
4. To learn basics of ballistics transport & spintronics

Course Outcomes:-

1. Ability to explain concepts of nanoelectronics including single electron effects & electron transport in nanoscopic system
2. Ability to describe concept of the quantum dot, the quantum wire, quantum well & nano applications of these structures
3. Ability to describe various new structures like CNTFET & SET
4. Ability to describe basic of spintronics & spin based devices

Module No.	Unit No.	Topics	Hrs.
1		**Classical particles , classical waves and Quantum Particles**	**10**
	1.1	Introduction to Nanotechnology	
	1.2	Comparison of classical and Quantum System	
	1.3	Origins of Quantum Mechanics	
	1.4	Electron as particle , electron as wave	
	1.5	Wave packets and uncertainty	
2		**Quantum Mechanics of Electron**	**10**
	2.1	General Postulates of Quantum Mechanics	
	2.2	Time Independent Schrodinger 's equation	
	2.3	Free electron: One dimensional and three dimensional space, Free electron Gas theory of metals	
	2.5	Partially confined electron. Finite potential well: Finite potential rectangular well, Parabolic well, Triangular well	
	2.6	Quantum Dot, Wires and wells	
3		**Single Electron and few Electron Phenomena and devices**	**10**
	3.1	Tunneling junctions and application of tunneling	
	3.2	Coulomb Blockade and The single Electron Transistor	
	3.3	Resonant Tunneling Diodes- principle and applications	
	3.4	Carbon Nanotube Transistor(FETs and SETs), Semiconductor Nanowire FETs and SETs	
	3.5	Molecular SETs and Molecular Electronics	
4		**Model of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots**	**10**
	4.1	Particles Statistics and density of states	
	4.2	Semiconductor heterostructures and Quantum Well	
	4.3	Quantum Wires and Nanowire	
	4.4	Fabrication Techniques for Nanostructures	
5		**Ballistic Transport , and Spin Transport**	**12**
	5.1	Ballistic Transport: Electron collision and length scale, Ballistic Transport Model ,Quantum Resistance and conductance	
	5.1	Spin Vs charge, AMR, GMR, TMR , The transport of spin	
	5.2	Spin devices- Spin valves, Magnetic tunnel junctions,	
	5.3	Applications – Memories (MRAM, STRAM), Logic device and Microwave Oscillators	
		TOTAL	**52**

Reference Books :-

1. George W. Hanson " Fundamental of Nanoelectronics", PEARSON

2. Rainer Waser, "Nano Electronics and Information Technology: Advanced Electronic Materials and Novel Devices", 2nd Edition, Wiley-VCH, 2012.

3. Chonles P. Poole Jr., Frank. J. Owens, "Introduction to Nanotechnology", John Wiley and Sons, 2009.

4. T. Pradeep, "Nano: The essentials", Tata McGraw Hill, 2007.

5. Mark A. Ratner, Danill Ratner, "Nano Technology: A Gentle Introduction to the Next Big Idea", Prentice Hall, 2003

6. Springer Handbook of Nanotechnology ISBN: 978-3-540-35172-6

Research Publications :-

1. Leland Chang, Yang-Kyu Choi, Daewon Ha, Pushkar Ranade, Shiying Xiong, Jeffrey Bokor, "Extremely Scaled Silicon Nano-CMOS Devices", PROCEEDINGS OF THE IEEE, VOL. 91, NO. 11, NOVEMBER 2003,pp-1860-1873.

2. Thomas Skotnicki, James A. Hutch by, Tsu-Jae King,H.-S. Philip Wong, and Frederic Boeuf,"The End of CMOS Scaling", IEEE CIRCUITS & DEVICES MAGAZINE, January 2005,pp-16-26.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks.

End Semester Examination:-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

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.

Research Publications :-

1. Rahman Jamal, Lothal Wenzel, "The Applicabilityof the Visual Programming Language LabVIEW to Large Real-World Applications" 1995, IEEE, 99-106

2. Željko Obrenovic, Dušan Starcevic, Emil Jovanov, "Virtual Instrumentation"

3. D.S.Benitez, A.Zaidi, A.Fitchet, P.A.Gaydecki and A.P.Fitzpatrick' "Virtual instrumentationfor clinical assessment of cardiovascular and autonomic function" *IEE Proc.-Sci. Meus. Technol.,Vol. 147, No. 6, November 2000,397-402*

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination :-

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO2021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project	8

	audit.	
	5.3 Project Contracting	
	Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:**	6
	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.	

Assessment:

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End Semester Theory Examination:
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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO2022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure		
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03	

Assessment:

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4. Only Four question need to be solved.

REFERENCES:
1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	**Enterpreneurship Development and Management**	**03**

Objectives:
1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…
1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

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4. Only Four question need to be solved.

REFERENCES:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	**Human Resource Management**	**03**

Objectives:
1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…
1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	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:
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End Semester Theory Examination:
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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, 15[th]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:

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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

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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
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

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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:
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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.

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.

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)