

# UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17  
Under

## FACULTY OF TECHNOLOGY

### **Electronics Engineering**

**Second Year** with Effect from AY 2017-18

**Third Year** with Effect from AY 2018-19

**Final Year** with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**  
with effect from the AY 2016-17

**B.E. (Electronics Engineering) – Semester VII**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Dept. Level Optional course III Lab.		02			01	---	01
	<b>TOTAL</b>	<b>19</b>	<b>14</b>	<b>---</b>	<b>19</b>	<b>07</b>	<b>---</b>	<b>26</b>

Course Code	Course Name	Examination Scheme – Semester VII									
		Theory					End Sem Exam Marks	Exam Duration (Hours)	Term Work	Oral /Prac	Total
		Internal Assessment (IA)			AVG.						
		Test I	Test II	AVG.							
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100		
ELX 702	Power Electronics	20	20	20	80	03	---	---	100		
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100		
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100		
ILO701X	Institute Level Optional Subject	20	20	20	80	03	---	---	100		
ELXL701	Instrumentation System Design Lab.						25	25	50		
ELXL702	Power Electronics Lab.						25	25	50		
ELXL703	Digital signal processing Lab.						25	25	50		
ELXL704	Project-I	---	---	---	---	---	50	50	100		
ELXLDLO703X	Dept. Level Optional courses III Lab.						25	25	50		
	<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>400</b>	<b>15</b>	<b>150</b>	<b>150</b>	<b>800</b>		

**Programme Structure for Bachelor of Engineering (B.E.) – Electronics Engineering (Rev. 2016)**

<b>Course Code</b>	<b>Department Level Optional Course III</b>	<b>Course Code</b>	<b>Institute Level Optional Course I<sup>o</sup></b>
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

<b>Course Code</b>	<b>Department Level Elective Course IV</b>	<b>Course Code</b>	<b>Institute Level Elective Course II<sup>#</sup></b>
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

**B.E. (Electronics Engineering)**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703 X	Dept. Level Optional course III Lab.		02			01	---	01
	<b>TOTAL</b>	<b>19</b>	<b>14</b>	<b>---</b>	<b>19</b>	<b>07</b>	<b>---</b>	<b>26</b>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELX801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804 X	Department Level Optional Courses IV Lab.		02			01	---	01
	<b>TOTAL</b>	<b>15</b>	<b>18</b>	<b>---</b>	<b>15</b>	<b>9</b>	<b>---</b>	<b>24</b>

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial I	Theory	TW/Practical I	Tutorial	Total
ELX 701	Instrumentation System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester			
		Test I	Test II	Average	Examination			
ELX 701	Instrumentation System Design (ISD)	20	20	20	80	---	---	100

**Rationale :-** For optimum operation & satisfactory performance of any industrial process control system, it is necessary to have a reliably engineered system with a thorough knowledge of the process conditions & requirements as per the system or design specifications. This subject introduces various nuances in the design of instrumentation systems, which is itself a synergy of sensors, transducers, actuators, process control & electronic systems to achieve the desired operation of a plant or the proper control of an industrial process. Students are exposed to principles of designing which enable them to design, build & implement such electronically controlled systems for measurement, signal conditioning & final control.

**Course Objectives :-**

1. To learn basic functions & working of pneumatic, hydraulic & electrical components used in process control
2. To understand principles of process parameter conversion & transmission in various forms
3. To gain familiarity with control system components & their applications in process control
4. To study various types of controllers used in process control & their tuning for different applications
5. To be aware of recent advances & technological developments in industrial instrumentation & process control

**Course Outcomes :-**

At the end of the course, students should gain the ability to :-

- **ELX 701.1 :-** Demonstrate the needs of advancement in instrumentation systems
- **ELX 701.2 :-** Select the proper components for pneumatic & hydraulic systems
- **ELX 701.3 :-** Choose the transmitter / controller for given process application
- **ELX 701.4 :-** Analyze the controller parameters for discrete or continuous type
- **ELX 701.5 :-** Design the controller (electronic) for a given process or application

<b>Module No.</b>	<b>Topics</b>	<b>Hours</b>
<b>1</b>	<b>ACTUATORS &amp; PROCESS CONTROL VALVES</b>	
<b>1.1</b>	Electrical actuators – relays, solenoids & electrical motors (DC, AC & stepper motor)	<b>08</b>
<b>1.2</b>	Pneumatic actuators – basic pneumatic system, pneumatic compressors (piston, vane, screw) flapper nozzle, single & double acting cylinder, rotary actuator, filter-regulator-lubricator (FRL)	
<b>1.3</b>	Hydraulic actuator – hydraulic pumps, control valves types (globe, ball, needle, butterfly, gate, diaphragm & pinch), cavitation & flashing with their remedies, pressure drop across valve & leakage, valve noise, flow characteristics on load changes, control valves parameters, control valves sizing, valve calibration, digital control valves, selecting control valves & applications	
<b>2</b>	<b>DESIGN OF SIGNAL CONDITIONING CIRCUITS</b>	
<b>2.1</b>	Principles of analog & digital signal conditioning – signal level & bias change, linearization, conversion, filtering & impedance matching, concept of loading, comparators & converters	<b>08</b>
<b>2.2</b>	Design of operational amplifier based circuits in instrumentation – analysis of voltage divider circuits, bridge circuits, RC filters, inverting & non-inverting amplifier, instrumentation amplifier, V to I & I to V converter, integrator, differentiator & linearization (with numerical examples)	
<b>2.3</b>	Transmitters – Introduction to telemetry & its basic block diagram, 2 wire, 3 wire & 4 wire transmitters, 4 mA to 20 mA current transmitter, electronic transmitters for temperature, level, pressure & flow, current to pressure (I to P) & pressure to current (P to I) converters	
<b>3</b>	<b>PROCESS CONTROLLER PRINCIPLES</b>	
<b>3.1</b>	Discontinuous controller – two position mode, multi-position mode & floating mode	<b>08</b>
<b>3.2</b>	Continuous controller – single mode (P, I & D) & composite mode (PD, PI & PID), split range, auto select, ratio & cascaded controllers, selection criterion of controller for a process mode	
<b>3.3</b>	Tuning of PID controller – process loop tuning, open loop transient response method, Ziegler – Nichols tuning method, frequency response methods (numerical examples on PID tuning)	
<b>4</b>	<b>PROGRAMMABLE LOGIC CONTROLLERS (PLC)</b>	
<b>4.1</b>	Discrete state process controller – discrete state variables, process specifications & event sequence description	<b>10</b>
<b>4.2</b>	Relay controller & ladder diagram – introduction to relay ladder diagram logic, ladder diagram elements & ladder diagram programming examples	

4.3	PLC – relay sequencers, programmable logic controller design, PLC operation, programming the PLC, PLC software functions (application examples on relay ladder logic programming)	
5	<b>DIGITAL BASED PROCESS CONTROL</b>	
5.1	Data acquisition system (DAS) – objectives, signal conditioning of inputs, single channel DAS, multi-channel DAS, computer based DAS, data logger, difference between DAS & data logger	08
5.2	Computer aided process control – architecture, human machine interface (HMI), supervisory control & data acquisition (SCADA), standard interfaces (RS-232C, RS-422A & RS-485)	
5.3	Supervisory control system (SCS), introduction to the Fieldbus & Profibus process controlled networks, overview of distributed control system (DCS), features & advantages of DCS	
6	<b>CALIBRATION STANDARDS &amp; ADVANCES IN INSTRUMENTATION</b>	
6.1	PC & microcomputer based instrumentation, virtual instrumentation & LabVIEW introduction	06
6.2	Calibration of instrumentation systems, representation of instrumentation control process with SAMA & ISA symbols, ISO/IEC 17025 General requirements for calibration standards	
6.3	Instrumentation standards, ISA S82.01 – Safety Standard for Electrical and Electronic Test, Measuring, Controlling Related Equipment, ISA S84.01 – Application of Safety Instrumented Systems for the Process Industries, ANSI/NEMA 250 – Enclosures for Electrical Equipment	
1 – 6	<b>TOTAL</b>	<b>48</b>

**Recommended Books :-**

1. Curtis D. Johnson, Process Control Instrumentation Technology, 7<sup>th</sup> edition, PHI
2. S. K. Singh, Industrial Instrumentation & Control, 3<sup>rd</sup> edition, McGraw Hill
3. B.C. Nakra & K. K. Chaudhary, Instrumentation Measurement & Analysis, 3<sup>rd</sup> edition, McGraw Hill
4. Andrew Parr, Pneumatics & Hydraulics, 2<sup>nd</sup> edition, Jaico Publishing Co.
5. B. G. Liptak, Handbook of Process Control & Instrumentation, 4<sup>th</sup> edition, CRC Press
6. William C. Dunn, Fundamentals of Industrial Instrumentation & Process Control, 1<sup>st</sup> edition, McGraw Hill

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

**End Semester Examination :-**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX702	Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX702	Power Electronics	20	20	20	80	03	--	--	--	100

**\Course Pre-requisite:**

1. ENAS
2. EDC-1
3. EDC-2

**Course Objectives:**

1. To teach power electronic devices and their characteristics.
2. To highlight power electronics based rectifiers, inverters and choppers.

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Discuss trade-offs involved in power semiconductor devices.
2. Design of triggering, commutation and protection circuits for SCRs.
3. Analyse different types of single-phase rectifiers and DC-DC converters.
4. Analyse different types of DC-AC converters (inverters).
5. Analyse different types of AC Voltage Controllers and Cycloconvertors.



<b>Module No.</b>	<b>Unit No.</b>	<b>Contents</b>	<b>Hrs.</b>
		<b>Power semiconductor devices</b>	
<b>1</b>	<b>1.1</b>	Principle of operation of SCR, static and dynamic characteristics, gate Characteristics,	<b>8</b>
	<b>1.2</b>	Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC, MOSFET and power BJT. IGBT: basic structure, principle of operation, equivalent circuit, latch-up in IGBT's and V-I characteristics.	
		<b>SCR: Triggering, commutation and Protection Circuits</b>	
<b>2</b>	<b>2.1</b>	Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine),	<b>8</b>
	<b>2.2</b>	Design of commutation circuits,	
	<b>2.3</b>	Protection of SCR	
		<b>Single-phase Controlled Rectifiers</b>	
<b>3</b>	<b>3.1</b>	Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	<b>8</b>
	<b>3.2</b>	Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.	
	<b>3.3</b>	Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HF/THD), Crest Factor (CF)), output performance parameters.	
		<b>Inverters</b>	
<b>4</b>	<b>4.1</b>	Introduction to basic and improved series/parallel inverters, limitations.	<b>10</b>
	<b>4.2</b>	Introduction, principle of operation, performance parameters of Single phase half / full bridge voltage source inverters with R and R-L load,	
	<b>4.3</b>	Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications	
		<b>DC-DC converters</b>	
<b>5</b>	<b>5.1</b>	Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators (CCM mode only)	<b>8</b>
	<b>5.2</b>	Voltage commutated, current commutated and load commutated DC-DC	

		converters	
	<b>5.3</b>	Applications in SMPS, Battery charging systems.	
		<b>AC Voltage Controllers and Cycloconvertors</b>	
<b>6</b>	<b>6.1</b>	Principle of On-Off control, principle of phase control, single phase bidirectional control with R and RL load	<b>6</b>
	<b>6.2</b>	Introduction, single phase and three phase Cyclo-converters, applications	
		<b>Total</b>	<b>48</b>

**Recommended Books:**

1. M. H. Rashid, "*Power Electronics*", Prentice-Hall of India
2. Ned Mohan, "*Power Electronics*", Undeland, Robbins, John Wiley Publication
3. P. S. Bhimbra, "*Power Electronics*", Khanna Publishers, 2012
4. M.D. Singh and K. B. Khanchandani, "*Power Electronics*", Tata McGraw Hill
5. Ramamurthy, "*Thyristors and Their Applications*"
6. P. C. Sen, "*Modern Power Electronics*", Wheeler Publication
7. S. Shrivastava, "*Power Electronics*", Nandu Publication, Mumbai.

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 and Test 2					
EXC703	Digital Signal Processing	20	20	20	80	--	--	--	100

**Prerequisite Courses:** Signals and Systems

**Course Objectives:**

1. To teach the design techniques and performance analysis techniques of digital filters
2. To introduce the students to advanced signal processing techniques, digital signal processors and applications

**Course Outcomes:**

**After successful completion of this course students will be able to**

1. Demonstrate an understanding of the discrete-time Fourier transform and the concept of digital frequency.
2. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
3. Understand the effect of hardware limitations on performance of digital filters
4. Use advanced signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Topics	Hrs.
1.0	<b>Discrete Fourier Transform and Fast Fourier Transform</b>		10
	1.1	Definition and Properties of DFT, IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT Filtering of long data sequences: Overlap Save and Overlap Add Method Computation of DFT	
	1.2	Fast Fourier transforms(FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT, and Introduction to composite FFT	
2.0	<b>IIR Digital Filters</b>		10
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band stop and All Pass) Analog filter approximations: Butterworth, Chebyshev I and II	
	2.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters from analog filters with examples	
	2.3	Analog and digital frequency transformations with design examples	
3.0	<b>FIR Digital Filters</b>		10
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zeros of linear phase FIR filters	

	3.2	Design of FIR filter using window techniques (Rectangular, Hamming, Hanning, Blackmann, Barlet) Design of FIR filter using Frequency Sampling technique Comparison of IIR and FIR filters	
		<b>Finite Word Length Effects in Digital Filters</b>	
4.0	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling	06
	4.2	Quantization in Floating Point realization of IIR digital filters Finite word length effects in FIR digital filters	
		<b>Multirate DSP and Filter Banks</b>	
5.0	5.1	Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer numbers Multistage Approach to Sampling rate converters	06
	5.2	Sample rate conversion using Polyphase filter structure, Type I and Type II Polyphase Decomposition	
		<b>DSP Processors and Applications</b>	
6.0	6.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator (MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism	06
	6.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware	
	6.3	Applications of DSP: Radar Signal Processing and Speech Processing	
<b>Total</b>			<b>48</b>

**Text Books:**

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing", A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2015

**Reference Books:**

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education
2. Sanjit K. Mitra, Digital Signal Processing – A Computer Based Approach – edition 4e
3. McGraw Hill Education (India) Private Limited
4. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education..
5. B. Venkata Ramani and M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, 2004.
6. L.R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2006.

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	20	20	20	80	-	--	--	100

**Pre-requisite**

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

**Course Objectives:**

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

**Course outcomes:**

**At the end of completing the course of Neural Networks & Fuzzy Logic, a student will be able to:**

1. Choose between different types of neural networks
2. Design a neural network for a particular application
3. Understand the applications of neural networks
4. Appreciate the need for fuzzy logic and control

Module	Contents	Hours
1	<p><b>Introduction:</b> 1.1 Biological neurons, McCulloch and Pitts models of neuron, Types of activation function, Network architectures, Knowledge representation, Hebb net</p> <p>1.2 Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning</p> <p>1.3 Learning Rules : Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner-Take-All Learning Rule</p> <p>1.4 Applications and scope of Neural Networks</p>	10
2	<p><b>Supervised Learning Networks :</b></p> <p>2.1 Perception Networks – continuous &amp; discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent, – least mean square algorithm, Linear &amp; non-linear separable classes &amp; Pattern classes,</p> <p>2.2 Back Propagation Network,</p> <p>2.3 Radial Basis Function Network.</p>	12
3	<p><b>Unsupervised learning network:</b></p> <p>3.1 Fixed weights competitive nets,</p> <p>3.2 Kohonen Self-organizing Feature Maps, Learning Vector Quantization,</p> <p>3.3 Adaptive Resonance Theory – 1</p>	06
4	<p><b>Associative memory networks:</b></p> <p>4.1 Introduction, Training algorithms for Pattern Association,</p> <p>4.2 Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory,</p> <p>4.3 Discrete Hopfield Networks.</p>	08
5	<p>Fuzzy Logic:</p> <p>5.1 Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence</p> <p>5.2 Fuzzification and Defuzzification</p> <p>5.3 Fuzzy Controllers</p>	12

<b>TOTAL</b>	<b>48</b>
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**Text- Books:**

- Dr. S. N. Sivanandam, Mrs S.N. Deepa, “*Principles of Soft computing*”, Wiley Publication.
- Jacek M. Zurada, “*Introduction to Artificial Neural Systems*”, Jaico publishing house.

**Reference books :**

- Simon Haykin, “*Neural Network a - Comprehensive Foundation*”, Pearson Education.
- S. Rajsekaran, Vijaylakshmi Pai, “*Neural Networks, Fuzzy Logic, and Genetic Algorithms*”, PHI.
- Thimothy J. Ross, “*Fuzzy Logic with Engineering Applications*”, Wiley Publication.
- Christopher M Bishop, “*Neural Networks For Pattern Recognition*”, Oxford Publication

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7032	Advanced Networking Technologies	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXDLO7032	Advanced Networking Technologies	20	20	20	80	-	--	--	100	

**Course Pre-requisite:** ELX405 Principles of Communication Engineering  
 ELX602 Computer Communication Network  
 ELXDLO-2 Wireless Communication

**Course Objectives:**

The objectives of this course are to:

1. Understand the characteristic features of Various Wireless networks
2. Understand Optical networking and significance of DWDM.
3. Introduce the need for network security and safeguards
4. Understand the principles of network management

**Course Outcomes:**

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

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM)
3. Understand the features of emerging wireless Networks: Bluetooth Networks,ZIGBEE, WSN
4. Analyze the importance of Optical networking
5. Demonstrate knowledge of network design and security and management
6. Understand the concept of Cloud Computing and its applications.

Module No.	Unit No.	Topics	Hrs.
<b>1.</b>		<b>Wireless LAN and WAN technologies</b>	<b>08</b>
	<b>1.1</b>	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations .	
	<b>1.2</b>	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM	



		cells , ATM Functional Layers, Congestion control and Quality of service	
<b>2.</b>		<b>Emerging Wireless Technologies</b>	<b>10</b>
	<b>2.1</b>	<b>Wireless Personnel Area Network(WPAN):</b> WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	<b>2.2</b>	802.15.3- Ultra Wide Band , 802.15.4- Zigbee , RFID	
	<b>2.3</b>	<b>Wireless Sensor Networks: Introduction and Applications,</b> Wireless Sensor Network Model, Sensor Network Protocol Stack,	
<b>3.0</b>		<b>Optical Networking</b>	<b>08</b>
	<b>3.1</b>	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	<b>3.2</b>	DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations	
<b>4.0</b>		<b>Network Design, Security and Management</b>	<b>10</b>
	<b>4.1</b>	3 tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	
	<b>4.2</b>	Network Security: Security goal, Security threats, security safeguards, firewall types and design.	
	<b>4.3</b>	Network management definitions, functional areas (FCAPS), SNMP,RMON	
<b>5.0</b>		<b>Routing in the Internet:</b>	<b>06</b>
	<b>5.1</b>	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	<b>5.2</b>	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
<b>6.0</b>		<b>Cloud computing:</b>	<b>06</b>
	<b>6.1</b>	Cloud Computing Evolution, Definition, SPI framework of Cloud Computing, Cloud service delivery models,	
	<b>6.2</b>	Cloud deployment models, key drivers to adoption of cloud, impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.	
<b>Total</b>			<b>48</b>

**Recommended Text Books:**

1. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
2. Darren L. Spohn , “Data Network Design” , McGraw Hill Education ,Third edition
3. William Stallings, “Data and Computer communications”, Pearson Education, 10<sup>th</sup> Edition.
4. Tim Mather , Subra Kumaraswamy & Shahed Latif, “Cloud security & Privacy: an enterprise Perspective”, O’Reilly Media Inc.Publishers

**Reference Books:**

1. William Stallings, “Wireless Communications and Networks”, Pearson Ed., 2<sup>nd</sup> Edition.

2. Vijay Garg ,”Wireless Communication and networking” , Morgan Kaufmann Publishers
3. Carr and Snyder, “ Data communication and network security” , McGraw Hill ,1<sup>ST</sup> edition.
4. Upena Dalal & Manoj Shukla , “ Wireless Communication and Networks” , Oxford Press
5. Deven Shah , Ambavade, “Advanced Communication Networking”
6. Behrouz A Forouzan , “TCP /IP Protocol Suite” , Tata McGraw Hill Education ,4<sup>th</sup> edition.

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7033	Robotics	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXDLO7033	Robotics	20	20	20	80	-	--	--	100	

**Pre-requisite:** Applied Mathematics III, Applied Mathematics IV ,Linear Control Systems

### Course Objectives:

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

### Course outcomes:

**At the end of completing the course of Robotics, a student will be able to:**

1. understand the basic concepts of robotics
2. perform the kinematic and the dynamic analysis of robots
3. perform trajectory and task planning of robots
4. describe importance of visionary system in robotic manipulation

Module	Contents	Hours
1	<b>Fundamentals of Robotics:</b> 1.1 Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	04
2	<b>Kinematics of Robots:</b> 2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation 2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	10
3	<b>Velocity Kinematics &amp; Dynamics:</b> 3.1 <b>Differential motions and velocities :</b> Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities, 3.2 <b>Dynamic Analysis of Forces :</b> Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot	10
4	<b>Trajectory planning:</b> 4.1 Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	08
5	<b>Robot Vision:</b> 5.1 Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration	08
6	<b>Task Planning:</b> 6.1 Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	08
<b>TOTAL</b>		<b>48</b>

**Text- Books :**

- Robert Shilling, “Fundamentals of Robotics - Analysis and contro”l, Prentice Hall of India, 2009
- Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011

**Reference books :**

- John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
- Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
- Mikell P. Groover et.al, ”Industrial Robots-Technology, Programming & applications”, McGraw Hill , New York, 2008

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	
ELXDLO7034	IC Technology	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXDL07034	IC Technology	20	20	20	80	--	--	--	100

**Course Pre-requisite:**

- ELX302:Electronic Devices and Circuits I
- ELX303:Digital Circuit Design
- ELX603:VLSI Design

**Course Objectives:**

1. To provide knowledge of IC fabrication processes and advanced IC technologies.
2. To disseminate knowledge about novel VLSI devices and materials.

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

1. Demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology.

Module No.	Unit No.	Topics	Hrs.
1.0		<b>Crystal Growth, Wafer preparation and fabrication for VLSI Technology</b>	8
	1.1	<b>Semiconductor Manufacturing:</b> Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering.	
	1.2	<b>Semiconductor Substrate:</b> Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2.0		<b>Fabrication Processes Part 1</b>	12
	2.1	<b>Epitaxy:</b> Classification, Molecular Beam Epitaxy	
	2.2	<b>Silicon Oxidation:</b> Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality.	
	2.3	<b>Device Isolation:</b> LOCOS, Shallow Trench Isolation (STI).	
	2.4	<b>Deposition: Physical Vapor Deposition-</b> Evaporation and Sputtering,	
	2.4	<b>Chemical Vapor Deposition:</b> APCVD, LPCVD,PECVD	
	2.4	<b>Diffusion:</b> Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion.	
	2.5	<b>Ion Implantation:</b> Penetration range-Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	
3.0		<b>Fabrication Process Part 2</b>	12
	3.1	<b>Etching &amp;Lithography:</b> <b>Etching:</b> Basic concepts and Classification <b>Lithography:</b> Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.2	<b>Metallization and Contacts:</b> Introduction to Metallization, Schottky contacts and Ohmic contacts.	
	3.3	<b>CMOS Process Flow:</b> N well, P-well and Twin tub, CMOS Latch Up	
	3.4	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried	

		and Butting Contact	
<b>4.0</b>		<b>Measurement and Testing</b>	06
	<b>4.1</b>	<b>Semiconductor Measurements:</b> Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility,	
	<b>4.2</b>	<b>Testing:</b> Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	
		<b>VLSI Technologies</b>	05
	<b>5.1</b>	<b>SOI Technology:</b> SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD SOI and FD SOI Device structure and their features	
	<b>5.2</b>	<b>Advanced Technologies:</b> low $\kappa$ and high $\kappa$ , BiCMOS, H $\kappa$ MG Stack, Strained Silicon.	
	<b>5.3</b>	<b>GaAs Technologies:</b> MESFET Technology, MMIC technologies, MODFET	
		<b>Novel Devices and Materials</b>	
	<b>6.1</b>	<b>Multigate Devices:</b> Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). <b>Nanowire:</b> Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires.	05
	<b>6.2</b>	<b>2-D Materials and FET:</b> Graphene & CNT FET, MOS <sub>2</sub> and Black Phosphorous.	
<b>Total</b>			<b>48</b>

**Recommended Books:**

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, “*Silicon VLSI Technology*”, Pearson, Indian Edition.
2. Stephen A. Campbell, “*The Science and Engineering of Microelectronic Fabrication*”, Oxford University Press, 2<sup>nd</sup> Edition.
3. Sorab K. Gandhi, “*VLSI Fabrication Principles*”, Wiley, Student Edition.
4. G. S. May and S. M. Sze, “*Fundamentals of Semiconductor Fabrication*”, Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, “*SOI Circuit Design Concepts*”, Kluwer Academic Publishers, 1<sup>st</sup> edition.



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

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction to Product Lifecycle Management (PLM):</b>Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance &amp; Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications</p> <p><b>PLM Strategies:</b>Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM</p>	10
02	<p><b>ProductDesign:</b>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</p>	09

03	<b>Product Data Management (PDM):</b> 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	<b>Virtual Product Development Tools:</b> 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	<b>Integration of Environmental Aspects in Product Design:</b> Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	<b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> 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, Antonino Risitano, "Product Design for the environment- A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", TataMcGrawHill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
01	<p><b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</p> <p><b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</p> <p><b>Measures of Dispersion:</b> Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</p>	08
02	<p><b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</p> <p><b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.</p> <p><b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</p>	08
03	<p><b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</p>	05
04	<p><b>Reliability Improvement:</b> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.</p>	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	<b>Maintainability and Availability:</b> 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	<b>Failure Mode, Effects and Criticality Analysis:</b> Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

**Assessment:****Internal:**

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

**End Semester Theory Examination:**

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

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

**REFERENCES:**

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

Course Code	Course Name	Credits
ILO7013	Management Information System	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
<b>06</b>	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process.  Acquiring Information Systems and Applications: Various System development life cycle models.	8

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **REFERENCES:**

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



Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
<b>01</b>	<p><b>Introduction</b></p> <p>1.1 Strategy of Experimentation</p> <p>1.2 Typical Applications of Experimental Design</p> <p>1.3 Guidelines for Designing Experiments</p> <p>1.4 Response Surface Methodology</p>	06
<b>02</b>	<p><b>Fitting Regression Models</b></p> <p>2.1 Linear Regression Models</p> <p>2.2 Estimation of the Parameters in Linear Regression Models</p> <p>2.3 Hypothesis Testing in Multiple Regression</p> <p>2.4 Confidence Intervals in Multiple Regression</p> <p>2.5 Prediction of new response observation</p> <p>2.6 Regression model diagnostics</p> <p>2.7 Testing for lack of fit</p>	08

03	<p><b>Two-Level Factorial Designs and Analysis</b></p> <p>3.1 The <math>2^2</math> Design</p> <p>3.2 The <math>2^3</math> Design</p> <p>3.3 The General <math>2^k</math> Design</p> <p>3.4 A Single Replicate of the <math>2^k</math> Design</p> <p>3.5 The Addition of Center Points to the <math>2^k</math> Design,</p> <p>3.6 Blocking in the <math>2^k</math> Factorial Design</p> <p>3.7 Split-Plot Designs</p>	07
04	<p><b>Two-Level Fractional Factorial Designs and Analysis</b></p> <p>4.1 The One-Half Fraction of the <math>2^k</math> Design</p> <p>4.2 The One-Quarter Fraction of the <math>2^k</math> Design</p> <p>4.3 The General <math>2^{k-p}</math> Fractional Factorial Design</p> <p>4.4 Resolution III Designs</p> <p>4.5 Resolution IV and V Designs</p> <p>4.6 Fractional Factorial Split-Plot Designs</p>	07
05	<p><b>Conducting Tests</b></p> <p>5.1 Testing Logistics</p> <p>5.2 Statistical aspects of conducting tests</p> <p>5.3 Characteristics of good and bad data sets</p> <p>5.4 Example experiments</p> <p>5.5 Attribute Vs Variable data sets</p>	07
06	<p><b>Taguchi Approach</b></p> <p>6.1 Crossed Array Designs and Signal-to-Noise Ratios</p> <p>6.2 Analysis Methods</p> <p>6.3 Robust design examples</p>	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, 3<sup>rd</sup> 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, 2<sup>nd</sup> Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGrawHill
7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO7015	Operations Research	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction to Operations Research:</b> Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> 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, <b>Duality</b>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> 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.</p> <p><b>Assignment Problem:</b> 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,</p>	14

	Travelling Salesman Problem <b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	<b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	<b>Simulation:</b> 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	<b>Dynamic programming.</b> 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	<b>Game Theory.</b> 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	<b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

**Assessment:****Internal:**

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

**End Semester Theory Examination:**

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

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

**REFERENCES:**

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

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

**Objectives:**

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

**Outcomes:** Learner will be able to...

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

Module	Detailed Contents	Hrs
01	<b>Introduction to Cybercrime:</b> Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2008, A global Perspective on cybercrimes.	4
02	<b>Cyber offenses &amp; Cybercrime:</b> How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	<b>Tools and Methods Used in Cyberline</b> 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	<b>The Concept of Cyberspace</b> E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	<b>Information Security Standard compliances</b> 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. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication



8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

**Objectives:**

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

**Outcomes: Learner will be able to...**

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction</b></p> <p>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.</p>	03
02	<p><b>Natural Disaster and Manmade disasters:</b></p> <p>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</p> <p>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.</p>	09
03	<p><b>Disaster Management, Policy and Administration</b></p> <p>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.</p>	06

	<p>3.2 Policy and administration:</p> <p>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.</p>	
04	<p><b>Institutional Framework for Disaster Management in India:</b></p> <p>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.</p> <p>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</p>	06
05	<p><b>Financing Relief Measures:</b></p> <p>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.</p> <p>5.2 International relief aid agencies and their role in extreme events.</p>	09
06	<p><b>Preventive and Mitigation Measures:</b></p> <p>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general</p> <p>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</p> <p>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.</p> <p>6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.</p>	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 Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yongg – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

**Objectives:**

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

**Outcomes: Learner will be able to...**

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

Module	Detailed Contents	Hrs
01	<b>Energy Scenario:</b> 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	<b>Energy Audit Principles:</b> 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	<b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. <b>Energy efficiency measures in lighting system, Lighting control:</b> 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	<b>Energy Management and Energy Conservation in Thermal Systems:</b> 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	<b>Energy Performance Assessment:</b> 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	<b>Energy conservation in Buildings:</b> Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

### Assessment:

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. [www.energymanagertraining.com](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://www.bee-india.nic.in)

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL701	Instrumentation System Design Laboratory	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)		End Semester Examination				
		Test I	Test II	Average				
ELXL701	Instrumentation System Design Laboratory	---	---	---	---	25	25	50

### **Term Work :-**

At least 06 experiments covering entire syllabus of ELX 701 (Instrumentation System Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.



**Suggested List of Experiments :-**

1. Study of pneumatic single acting & double acting cylinder
2. Study of hydraulic process control valves
3. Design of stepper motor interface & controller
4. Design of instrumentation amplifier for variable voltage gain
5. Design of signal conditioning circuits for LDR / thermistor / RTD / strain gauge
6. Design of linearization circuits for transducers
7. Design of temperature P+I+D controller
8. Tuning of P+I+D controller using MATLAB / Simulink
9. Implementation of PLC ladder diagram for given application
10. Study of SCADA & HMI
11. Designing of data acquisition system (DAS)
12. Simulating a simple process using LabVIEW

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL702	Power Electronics	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL702	Power Electronics	---	---	---	---	25	25	50

**Term Work :-**

At least 06 experiments covering entire syllabus of ELX 702 (Power Electronics) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will

be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

#### Suggested List of Experiments

1. Characteristics of SCR, DIAC, TRIAC.
2. Characteristics of IGBT, MOSFET and Power BJT.
3. Firing circuit for SCR using UJT.
4. Study of Half wave and Full wave rectifiers using diodes.
5. Study of Half wave and Full wave controlled rectifiers.
6. Buck converter, Boost converter and Buck-Boost converter.
7. Study of Cycloconverter.
8. Simulation of single phase Half wave and Full wave rectifier circuit.
9. Simulation of controlled rectifier with R and RL load.
10. Simulation of controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL703	Digital Signal Processing	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL703	Digital Signal Processing	---	---	---	---	25	25	50

### Instructions

1. Minimum 6 experiments and one course project must be submitted by each student.
2. Simulation tools like Matlab/Scilab can be used.
3. Processor based experiments/mini projects can be included.  
The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

### Tentative List of Experiments:

1. Study of Convolution, Series and Parallel Systems
2. Generation of Basic Signals
3. Computation of DFT and it's inverse
4. Computation of FFT and comparison of frequency response of DFT and FFT
5. Computation of DFT
6. IIR Butterworth filter design using IIT technique
7. IIR Chebyshev filter design using BLT technique
8. Design of FIR filter using hamming and hanning window, low pass and high pass filter

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXD OLO70 31	NEURAL NETWORKS & FUZZY LOGIC	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXD OLO70 31	NEURAL NETWORKS & FUZZY LOGIC	---	---	---	---	25	25	50

**Term Work:**

The term work shall consist of

1. At least **six experiments** using MATLAB Or C/C++ or Java covering the whole of syllabus, duly recorded and graded.
2. **One seminar and Two assignments** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

**Suggested List of experiments: using C/C++ or Matlab or java**

- Activation functions
- McCulloch Pitts Neuron Model
- Hebbian learning
- Single layer perceptron neural network
- Multi-layer perceptron neural network

- Error Back propagation neural network
- Kohonen Self-organizing Feature Maps
- Associative memory network
- Fuzzy relations
- Defuzzification methods

**Suggested List of seminar :**

- Classification of upper case and lower case letters.
- Classification of numbers 0-9.
- BPN for training a hidden layer.
- Implement a heteroassociative memory network to implement any pattern.
- Implement discrete Hopfield network for letters A-E.
- Implement BAM for a pattern of 5X3 array.
- Fuzzy Logic controller design – washing machine / vehicle speed control.

**Oral Examination:**

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	-	-	-	25	--	25	50	

**Course Objectives:**

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

**Suggested Experiments:**

1. Evaluation of home/campus network
2. GSM-GPS protocol implementation
3. Bluetooth protocol implementation
4. ZigBee protocol implementation
5. Wi-Fi protocol implementation
6. Study of NMAP
7. Study of SNMP
8. Study of Ethernet.

**Suggested topics for presentation:**

1. MANET
2. VOFR
3. VOIP
4. X.25
5. Body area network
6. RFID
7. Web Security
8. Compression Techniques
9. Security attacks
10. NAT
11. College campus network

12. Fiber Optics types, advantages disadvantages
13. WSN

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7033	Robotics	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXLDLO7033	Robotics	-	-	-	-	25	--	25	50	

**Term Work:**

The term work shall consist of

- At least *eight experiments* using MATLAB / Scilab covering the whole of syllabus, duly recorded and graded.
- Two assignments* to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

**Suggested List of experiments: using Matlab / Scilab**

- Forward kinematics
- Inverse kinematic
- Dynamic analysis
- Joint-space trajectory
- Cartesian-space trajectory
- Template matching
- Iterative processing
- Segmentation



Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7034	IC Technology	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXLDLO7034	IC Technology	-	-	-	-	25	--	25	50	

**Course Objectives:**

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

**Suggested Experiments:**

*Following list of experiments covers the complete syllabus prescribed in IC Technology course. It is formulated in such a way that it allows student to explore various process, layout and device simulation tools. Detail analysis of observations should be recorded in the project book. Tools to be used are Microwind, SUPREME, Electric, Visual TCAD, Mentor Graphics Pyxis and tools available on nanohub. Linux based operating system is preferred to do simulations.*

1. Draw and simulate layout for the CMOS inverter. Carry out static as well as transient simulation. Analyze CMOS inverter for i)  $(W/L)_{pmos} > (W/L)_{nmos}$  ii)  $(W/L)_{pmos} = (W/L)_{nmos}$  iii)  $(W/L)_{pmos} < (W/L)_{nmos}$ . Do parasitic extraction. Feed these parasitic in circuit simulator and do layout versus schematic verification.

2. Draw and simulate layout for the following circuits. Size them with respect to reference inverter.

- a. CMOS NAND
- b. CMOS NOR

Also observe the effect of different types of design rules on above circuits and tabulate the comparative results.

3. Draw and simulate layout for the given equation (each student will get different equation  $[y = \frac{A \cdot B + C \cdot D}{\dots}]$ ) with the following design style

- a. Static CMOS
- b. Transmission gate
- c. Dynamic Logic

4. Draw and simulate layout for 6T SRAM cell. Size the SRAM cell for 1) lowest area 2) high reliability

5. Draw and simulate layout for the following circuits.

a. SR latch

b. D flip Flop

6. Simulate oxidation process with Deal-Grove model for different conditions (e.g. oxidation type, orientation, time, temperature, thickness etc.) and comment on the results obtained.
7. Simulate diffusion process for different conditions (e.g. source, time, temperature, dopant etc.) and comment on the results obtained.
8. Simulate Si PN junction for various structure and environmental conditions and comment on the results obtained. Repeat the entire simulation for Ge diode.
9. Simulate MOS capacitor (Classical Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.
10. Simulate MOS capacitor (Quantum Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

**Suggested topics for presentation:**

Presentation on any Novel device or process.