

# 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

**Co-ordinator, Faculty of Technology's Preamble:**

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

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

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

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

**Chairman’s Preamble:**

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Electronics Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Electronics Engineering. The Program Educational Objectives finalized for the undergraduate program in Electronics Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner’s point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

**Dr.Sudhakar S. Mande**

**Chairman, Board of Studies in Electronics Engineering, University of Mumbai**

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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELXL801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
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	Examination Scheme – Semester VIII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
Test I	Test II	AVG.							
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Lab.						25	25	50
ELXL802	Analog and Mixed VLSI Design Lab.						25	25	50
ELXL803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804 X	Department Level Optional Courses IV Lab.						25	25	50
	<b>Total</b>	<b>80</b>	<b>80</b>	<b>80</b>	<b>320</b>	<b>15</b>	<b>150</b>	<b>150</b>	<b>700</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>n</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) – Semester VIII**

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 801	Internet of Things	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 801	Internet of Things	20	20	20	80	-	--	--	100

**Course Pre-requisite:** ELX 501 :- Micro-controllers and Applications  
 ELX 601:- Embedded System and RTOS  
 ELX602:- Computer Communication Network  
 ELXDLO-2 Wireless Communication

**Course Objectives:**

The objectives of this course are to:

1. Understand the design features of Internet of Things(IoT)
2. Understand importance of data handling in IoT Way.
3. Introduce multiple way of data communication and networking.
4. Understand design issue in IoT

**Course Outcomes:**

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

1. Understand the concepts of Internet of Things
2. Analyze basic web connectivity in IoT
3. Understand Data handling in IoT
4. Design basic applications based on IoT using specific components

Module No.	Unit No.	Topics	Hrs.
1.		<b>Introduction to IoT</b>	<b>08</b>
	1.1	<b>Introduction;</b> -Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, and M2MCommunication.	
	1.2	<b>Iot and M2m:-</b> IoT/M2M System layers and Design Standardization, Difference between IoT and M2M	
2.		<b>Network &amp; Communication aspects</b>	<b>10</b>

	<b>2.1</b>	<b>Design Principles &amp; Web Connectivity:-</b> Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets  (Publish –Subscribe),MQTT, AMQP, CoAP Protocols	
	<b>2.2</b>	<b>Internet Connectivity:</b> - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols.  LPWAN Fundamentals :LORA ,NBIoT,CAT LTE M1,SIGFOX	
<b>3.0</b>		<b>IoT Platforms and Design Methodology</b>	<b>08</b>
	<b>3.1</b>	<b>Defining Specifications About:-</b> Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, (case studies)	
	<b>3.2</b>	<b>IoT Levels:-</b> IoT Levels and Deployment Templates	
<b>4.0</b>		<b>Data Handling in IoT</b>	<b>10</b>
	<b>4.1</b>	<b>Data Acquiring, Organizing, Processing:-</b> Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	
	<b>4.2</b>	<b>Data Collection and Storage:-</b> Cloud Computing Paradigm for Data Collection, storage and computing, Cloud Service Models, Xively Cloud for IoT (AWS ,Google APP engine ,Dweet.IO, Firebase)	
<b>5.0</b>		<b>Components of IoT</b>	<b>06</b>
	<b>5.1</b>	<b>Exemplary Devices:-</b> Raspberry Pi, R-Pi Interfaces, Programming R-Pi, Sensor Technology, Sensor Data Communication Protocols, RFID, WSN Technology, Intel Galileo	
<b>6.0</b>		<b>IoT Case Studies</b>	<b>06</b>
	<b>6.1</b>	Design Layers, complexity, IoT Applications in Premises, Supply Chain and Customer Monitoring.	
	<b>6.2</b>	Home Automation, Smart Cities, Environment, Agriculture, IoT Printer	
<b>Total</b>			<b>48</b>

**Recommended Text Books:**

5. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
6. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, First edition
7. David Hanes, Gonzalo Salgueiro "IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition
8. Andrew Minter, "Analytics for the Internet of Things (IoT)", Kindle Edition

**Reference Books:**

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Paperback, First Edition
2. Yashavant Kanetkar, Shrirang Korde : Paperback "21 Internet of Things (IOT) Experiments"
  - a. BPB Publications

**Internal Assessment (IA):**

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

**End Semester Examination:**

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



Subject Code	Subject Name	Teaching Scheme			Credits Assigned					
		Theory	Practical	Tutorial	Theory	T/W Practical	Tutorial	Total		
ELX802	Analog and Mixed VLSI Design	04	02	-	04	-	-	04		
		<b>Examination Scheme</b>								
		<b>Theory Marks</b>				Exam Duration (Hrs)	Term work	Practical	Oral	Total
		<b>Internal Assessment Marks</b>			End Sem Exam (Marks)					
		Test 1	Test 2	Average						
ELX802	Analog and Mixed VLSI Design	20	20	20	80	03	-	-	-	100

**Course Pre-requisite:**

- ELX302: Electronic Devices and Circuits I
- ELX303: Digital Circuit Design
- ELX402: Electronic Devices and Circuits II
- ELX504: Design With Linear Integrated Circuits
- ELX603: VLSI Design
- ELX DLO-3: IC Technology

**Course Objectives:**

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.
3. To emphasize upon the issues related to mixed signal layout design.

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

1. Discuss tradeoffs involved in analog VLSI Circuits.
2. Analyze building blocks of CMOS analog VLSI circuits.
3. Design building blocks of CMOS analog VLSI circuits
4. Carry out verifications of issues involved in analog and mixed signal circuits

Module No	Unit No	Topics	Hrs
1.0		<b>Analog building blocks</b>	8
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror.	
	1.2	<b>Voltage References:</b> Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT	

		current generation and Constant Gm biasing	
		<b>Amplifier Fundamentals</b>	
2.0	2.1	<b>Single Stage Amplifiers:</b> Basic concepts, Gain Bandwidth (GBW), Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascode stage.	12
	2.2	<b>Differential Amplifiers:</b> Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.	
	2.3	<b>Noise:</b> Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise in differential pairs, noise bandwidth, noise figure, noise temperature.	
		<b>MOS Operational Amplifiers</b>	
3.0	3.1	<b>Stability and Frequency Compensation:</b> General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps	8
	3.2	<b>Op-amp Design:</b> General Considerations, performance parameters, One-stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations(ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps	
		<b>Mixed Signal Circuits</b>	
4.0	4.1	<b>Basic Concepts:</b> AMS design flow, ASIC, Full custom design, Semi-custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	8
	4.2	<b>Oscillators:</b> General considerations, Ring oscillators, LC oscillators, VCO,	
	4.3	<b>Phase-Locked Loop:</b> Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
		<b>Data Converter Fundamentals</b>	
5.0	5.1	<b>Switch Capacitor Circuits:</b> MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non- inverting amplifier and integrator.	4
	5.2	Basic CMOS comparator Design, Adaptive biasing, Analog multipliers.	
		<b>Data Converter Fundamentals and Architectures</b>	
6.0	6.1	<b>Fundamentals:</b> Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	8
	6.2	<b>DAC architectures:</b> Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC <b>ADC architectures:</b> Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs	
		<b>Total</b>	<b>48</b>

**Recommended Books:**

1. B Razavi, “*Design of Analog CMOS Integrated Circuits*”, Tata McGraw Hill, 1<sup>st</sup> Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, “*CMOS Circuit Design, Layout, and Simulation*”, Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, “*CMOS Analog Circuit Design*”, Oxford University Press, 3<sup>rd</sup> Edition.
4. Gray, Meyer, Lewis, Hurst, “*Analysis and design of Analog Integrated Circuits*”, Willey, 5<sup>th</sup> Edition

**Internal Assessment (IA)**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned						
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total			
ELX DLO8041	Advanced Power Electronics	04	02	--	04	--	--	04			
Subject Code	Subject Name	Examination Scheme									
		Theory Marks						Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours					
		Test 1	Test 2	Avg of Test 1 and Test 2							
ELX DLO8041	Advanced Power Electronics	20	20	20	80	03	--	--	--	100	

**Course Pre-requisite:**

4. Power Electronics.
5. Linear Control System.
6. BEE

**Course Objectives:**

3. To enhance the ideas of students for more complex power electronic system.
4. To teach the analytical methods in power electronic systems.
5. To expose the students to various applications of power electronics in electronics equipment, drives and non-conventional energy systems.

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

1. Thoroughly understand the modern methods of analysis and control of power electronic systems.
2. Carry out the theoretical analysis of the power electronic systems from the 'Systems Theory' point of view.
3. Appreciate the ubiquity of power electronic systems in engineering fields.
4. Simulate and analyse power electronic systems.

Module No.	Unit No.	Contents	Hrs.
1		<b>Three-phase Rectifiers</b>	8
	1.1	3-phase half-wave and full-wave controlled rectifiers with R and RL load, Effect of source inductance,	
	1.2	Distortion in line current, calculation of performance parameters.	
2		<b>Three-phase inverters and control</b>	8
	2.1	Three phase bridge inverters ( $120^\circ$ and $180^\circ$ conduction mode) with R and RL load	
	2.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
3		<b>DC-DC Converters</b>	10
	3.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters.	
	3.2	Feedback control of these converters (PI and PID).	
4		<b>Power Electronic Applications in DC Drives</b>	8
	4.1	Introduction to DC motors, speed control of DC motor, drives with semi converters, full converters and dual converters.	
	4.2	Chopper-based drive.	
	4.3	Electric braking of DC motors.	
5		<b>Power Electronic Applications in AC Drives</b>	10
	5.1	Introduction to three-phase induction motor, speed control methods for three-phase induction motor : i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Slip power recovery schemes	
6		<b>Power Electronic Applications</b>	4
	6.1	Induction heating, dielectric heating, solid state relays,	

	<b>6.2</b>	Energy conversion interface in renewable energy system.	
<b>Total</b>			<b>48</b>

**Recommended Books:**

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3<sup>rd</sup> Edition.
2. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2<sup>nd</sup> Edition.
3. Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2<sup>nd</sup> Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2<sup>nd</sup> Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned						
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total			
ELX DLO8042	MEMS Technology	04	02	--	04	--	--	04			
Subject Code	Subject Name	Examination Scheme									
		Theory Marks						Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours					
		Test 1	Test 2	Avg of Test 1 and Test 2							
ELX DLO8042	MEMS Technology	20	20	20	80	03	--	--	--	100	

**Course Pre –requisite: VLSI Design an IC Technology**

**Course Objectives:**

1. To provide knowledge of MEMS processing steps and processing modules
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and structures.

**Course Outcomes:**

1. Understand the underlying fundamental principles of MEMS devices including physical operation and material properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of micro system sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

<b>Module No.</b>	<b>Unit No.</b>	<b>Contents</b>	<b>Hrs.</b>
<b>1</b>		<b>Introduction to MEMS</b>	<b>4</b>
	<b>1.1</b>	Introduction to MEMS, Comparison with Micro Electronics Technology,	
	<b>1.2</b>	Real world examples (Air-Bag, DMD, Pressure Sensors), MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications	
<b>2</b>		<b>MEMS Materials and Their Properties</b>	<b>8</b>
	<b>2.1</b>	Materials (eg. Si, SiO <sub>2</sub> , SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt)	
	<b>2.2</b>	Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.	
<b>3</b>		<b>MEMS Sensors, Actuators and Structures</b>	<b>8</b>
	<b>3.1</b>	MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	
	<b>3.2</b>	Micro Actuation Techniques (Thermal, Piezo electric, Electro static, Shape Memory Alloys, <b>LORENTZ FORCE ACTUATION</b> ), Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.	
<b>4</b>		<b>MEMS Fab Processes</b>	<b>10</b>
	<b>4.1</b>	MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio Micro	
	<b>4.2</b>	Machining (LIGA, Laser), X-Ray Lithography, Photolithography, PVD techniques, Wet, Dry, Plasma	
	<b>4.3</b>	etching, DRIE, Etch Stop Techniques. Die, Wire & Wafer Bonding, Dicing, Packaging(with Metal	
<b>5</b>		<b>MEMS Devices</b>	<b>12</b>
	<b>5.1</b>	Architecture, working and basic behaviour of Cantilevers, Micro heaters, Accelerometers, Pressure Sensor types, Micromirrors in DMD, Inkjet printer-head. Steps involved in Fabricating above devices	
<b>6</b>		<b>MEMS Device Characterization</b>	<b>6</b>



	<b>6.1</b>	Piezo-resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior	
	<b>6.2</b>	MEMS Failure Mechanisms and Reliability.	
<b>Total</b>			<b>48</b>

**Recommended Books:**

1. MEMS and MICROSYSTEMS Design and Manufacture by Tai Ran Hsu : McGraw Hill Education
2. An Introduction to Micro-electromechanical Systems Engineering; 2 <sup>nd</sup> Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
3. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
4. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
5. Micro-system Design - by S. Senturia; Publisher: Springer
6. Analysis and Design Principles of MEMS Devices - Minhang Bao; Publisher: Elsevier Science
7. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2 edition
8. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8043	Virtual Instrumentation	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDL O8043	Virtual Instrumentation	20	20	20	80	-	-	100

**Rationale :-** Virtual instrumentation combines mainstream commercial technologies such as the PC, with flexible software and a wide variety of measurement hardware, so one can create user-defined systems that meet their exact application needs. Virtual instrumentation has led to a simpler way of looking at measurement systems. Instead of using several stand-alone instruments for multiple measurement types and performing rudimentary analysis by hand, engineers now can quickly and cost-effectively create a system equipped with analysis software and a single measurement device that has the capabilities of a multitude of instruments for various applications & measurements.

### **Course Objectives :-**

1. To understand virtual instrumentation (VI) & to realize its architecture
2. To familiarize with VI software & learn programming in VI
3. To study various instruments interfacing & data acquisition methods
4. To understand various analysis tools & develop programs for different measurement applications

### **Course Outcomes :-**

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

- **CO-1 :-** Explain the concepts of virtual instrumentation
- **CO-2 :-** Select the proper data acquisition hardware
- **CO-3 :-** Configure the data acquisition hardware using LabVIEW
- **CO-4 :-** Use LabVIEW to interface related hardware like transducers
- **CO-5 :-** Design virtual instruments for practical applications

<b>Module No.</b>	<b>Topics</b>	<b>Hours</b>
<b>1</b>	<b>INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)</b>	
<b>1.1</b>	Historical perspective – Need for VI – Advantages of VI – Definition of VI – Block diagram & architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming	<b>06</b>
<b>2</b>	<b>PROGRAMMING TECHNIQUES</b>	
<b>2.1</b>	VI & sub-VI – Loops & charts – Arrays – Clusters – Graphs – Case & sequence structures – Formula nodes – Local & global variables – String & files inputs	<b>08</b>
<b>3</b>	<b>APPLICATION DEVELOPMENT SOFTWARE (LabVIEW)</b>	
<b>3.1</b>	Creating virtual instrument in LabVIEW – Implementing dataflow programming in LabVIEW – VI, sub-VI & modular code creation in LabVIEW – Arrays & file I/O in LabVIEW – Textual math integration in LabVIEW – Interfacing external instruments to PC using LabVIEW	<b>10</b>
<b>4</b>	<b>DATA ACQUISITION BASICS</b>	
<b>4.1</b>	Digital I/O – Counters & timers – PC hardware structure – Timing – Interrupts – DMA – Software & hardware installation – IEEE GPIB 488 concepts – Embedded system buses – PCI – EISA – CPCI	<b>08</b>
<b>5</b>	<b>COMMON INSTRUMENT INTERFACES</b>	
<b>5.1</b>	Current loop – RS 232C / RS 485 – Interface basics – USB – PCMCIA – VXI – SCXI – PXI – Networking basics for office & industrial application VISA & IVI – Image acquisition & process – Motion control – Digital multimeter (DMM) – Waveform generator	<b>08</b>
<b>6</b>	<b>USING ANALYSIS TOOLS &amp; APPLICATION OF VI</b>	
<b>6.1</b>	Fourier transform – Power spectrum – Correlation method – Windowing & filtering – Pressure control system – Flow control system – Level control system – Temperature control system – Motion control employing stepper motor – PID controller toolbox	<b>08</b>
<b>1 – 6</b>	<b>TOTAL</b>	<b>48</b>

**Recommended Books :-**

1. Dr. Sumathi S. & Surekha P, LabVIEW Based Advanced Instrumentation System, PHI, 2nd edition (2007)
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, 2<sup>nd</sup> edition (2006)
3. Lisa K. Wells & Jeffrey Travis, LabVIEW for Everyone, PHI, 3<sup>rd</sup> edition (2009)

4. Robert H. Bishop, Learning with LabVIEW 7 Express, Pearson Education, 1<sup>st</sup> edition (2005)
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2<sup>nd</sup> edition (2010)

**Internal Assessment (IA) :-**

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

**End Semester Examination :-**

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8044	Digital Image Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDL O 8044	Digital Image Processing	20	20	20	80	-	-	100

**Course Pre-requisite:**

- Applied Mathematics
- Signals and Systems

**Course Objectives:**

1. To learn the fundamental concepts of Digital Image Processing through basic spatial and frequency domain techniques.
2. To learn Image Compression and Decompression Techniques and compression standards.

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

1. Understand the fundamentals of Digital Image representation and simple pixel relations.
2. Explain spatial domain and frequency domain techniques for digital image enhancement.
3. Perform segmentation and morphological operations.
4. Apply compression and decompression techniques to different digital images.

Module No.	Unit No.	Topics	Hrs.
1		<b>Digital Image Processing Fundamentals</b>	04
	1.1	<b>Introduction:</b> Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	<b>Digital Image Fundamentals:</b> Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels,	
		Image File Formats : BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	
2		<b>Image Enhancement in Spatial Domain</b>	08
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging,	
		Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter	
3		<b>Image Segmentation and Representation</b>	08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique	
		3.2	
	4		
4.1		Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling	
5		<b>Image Transforms and frequency domain processing</b>	12
	5.1	Introduction to 2 Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform(FFT), Computation of 2 DFFT	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete	

		Cosine Transform(DCT), Introduction to Discrete Wavelet Transform (DWT)	
	5.3	Enhancement in the frequency domain: Frequency Domain Filtering Lowpass Filtering, Highpass Filtering, Homomorphic Filtering, Generation of Spatial Masks from Frequency Domain Specifications	
6		<b>Image Compression:</b>	
	6.1	Fundamentals :Coding Redundancy, Interpixel Redundancy, Psycho visual Redundancy	
	6.2	Image Compression Models :The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	10
6.3	Lossy Compression Techniques: Predictive Coding, Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1. , Fidelity Criteria.		
<b>Total</b>			<b>48</b>

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

**Reference Books:**

1. S. Jayaraman, E. Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Second Edition, Thomson Learning, 2001
3. William K. Pratt, "Digital Image Processing", Third Edition, John Wiley & Sons, Inc., 2001

**Internal Assessment (IA) :-**

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

**End Semester Examination :-**

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

e Code	Course Name	Credits
ILO8021	Project Management	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<b>Project Management Foundation:</b> 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	<b>Initiating Projects:</b> 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	<b>Project Planning and Scheduling:</b> Work Breakdown structure (WBS) and linear responsibility chart, Interface  Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	8



	GANTT chart. Introduction to Project Management Information System (PMIS).	
04	<p><b>Planning Projects:</b></p> <p>Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.</p> <p>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</p>	6
05	<p><b>5.1 Executing Projects:</b></p> <p>Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.</p> <p>Team management, communication and project meetings.</p> <p><b>5.2 Monitoring and Controlling Projects:</b></p> <p>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p><b>5.3 Project Contracting</b></p> <p>Project procurement management, contracting and outsourcing,</p>	8
06	<p><b>6.1 Project Leadership and Ethics:</b></p> <p>Introduction to project leadership, ethics in projects.</p> <p>Multicultural and virtual projects.</p> <p><b>6.2 Closing the Project:</b></p> <p>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.</p>	6

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

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

**End Semester Theory Examination:**

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

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

**REFERENCES:**

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

Course Code	Course Name	Credits
ILO8022	Finance Management	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p><b>Concepts of Returns and Risks:</b> 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.</p> <p><b>Time Value of Money:</b> 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.</p>	06
03	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;</p>	09

	Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04	<p><b>Capital Budgeting:</b> 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)</p> <p><b>Working Capital Management:</b> 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.</p>	10
05	<p><b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p><b>Capital Structure:</b> 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</p>	05
06	<b>Dividend Policy:</b> Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

### Assessment:

#### **Internal:**

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

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

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

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

**REFERENCES:**

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

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

**Objectives:**

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

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

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	<p><b>Overview Of Entrepreneurship:</b> 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</p> <p>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship</p>	04
02	<p><b>Business Plans And Importance Of Capital To Entrepreneurship:</b> 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</p> <p><b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations</p>	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	<b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,	08

	Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
05	<b>Effective Management of Business:</b> 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	<b>Achieving Success In The Small Business:</b> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

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

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

**End Semester Theory Examination:**

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

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

**REFERENCES:**

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

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction to HR</b></p> <ul style="list-style-type: none"> <li>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</li> <li>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</li> </ul>	5
02	<p><b>Organizational Behavior (OB)</b></p> <ul style="list-style-type: none"> <li>• Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues</li> <li>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> <li>• Perception: Attitude and Value, Effect of perception on Individual Decision-</li> </ul>	7



	<p>making, Attitude and Behavior.</p> <ul style="list-style-type: none"> <li>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</li> <li>• 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.</li> <li>• Case study</li> </ul>	
03	<p><b>Organizational Structure &amp; Design</b></p> <ul style="list-style-type: none"> <li>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	6
04	<p><b>Human resource Planning</b></p> <ul style="list-style-type: none"> <li>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</li> <li>• Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counseling, Career Planning.</li> <li>• Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>	5
05	<p><b>Emerging Trends in HR</b></p> <ul style="list-style-type: none"> <li>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>• 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.</li> </ul>	6
06	<p><b>HR &amp; MIS</b></p> <p>Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries)</p> <p><b>Strategic HRM</b></p> <p>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</p>	10

	<p><b>Labor Laws &amp; Industrial Relations</b></p> <p>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	
--	--	--

### **Assessment:**

#### **Internal:**

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

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

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

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

#### **REFERENCES:**

1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporat Social Responsibility (CSR)	03

**Objectives:**

1. To understand professional ethics in business
2. To recognized corporate social responsibility

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

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	<b>Professional Ethics and Business:</b> 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	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy  <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	<b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy  <b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	<b>Introduction to Corporate Social Responsibility:</b> 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	<b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship	08

	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06	<b>Corporate Social Responsibility in Globalizing India:</b> Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

### **Assessment:**

#### **Internal:**

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

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

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

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

#### **REFERENCES:**

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

**Objectives:**

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

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

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	<p><b>Introduction and Basic Research Concepts</b></p> <p>1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</p> <p>1.2 Need of Research in Business and Social Sciences</p> <p>1.3 Objectives of Research</p> <p>1.4 <b>Issues</b> and Problems in Research</p> <p>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</p>	09
02	<p><b>Types of Research</b></p> <p>2.1. Basic Research</p> <p>2.2. Applied Research</p> <p>2.3. Descriptive Research</p> <p>2.4. Analytical Research</p> <p>2.5. Empirical Research</p> <p>2.6 Qualitative and Quantitative Approaches</p>	07

03	<p><b>Research Design and Sample Design</b></p> <p>3.1 Research Design – Meaning, Types and Significance</p> <p>3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors</p>	07
04	<p><b>Research Methodology</b></p> <p>4.1 Meaning of Research Methodology</p> <p>4.2. Stages in Scientific Research Process:</p> <p>a. Identification and Selection of Research Problem</p> <p>b. Formulation of Research Problem</p> <p>c. Review of Literature</p> <p>d. Formulation of Hypothesis</p> <p>e. Formulation of research Design</p> <p>f. Sample Design</p> <p>g. Data Collection</p> <p>h. Data Analysis</p> <p>i. Hypothesis testing and Interpretation of Data</p> <p>j. Preparation of Research Report</p>	08
05	<p><b>Formulating Research Problem</b></p> <p>5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</p>	04
06	<p><b>Outcome of Research</b></p> <p>6.1 Preparation of the report on conclusion reached</p> <p>6.2 Validity Testing &amp; Ethical Issues</p> <p>6.3 Suggestions and Recommendation</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 at least 6 assignment on complete syllabus or course project.

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

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

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

### **REFERENCES:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

**Objectives:**

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

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

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	<b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. <b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	<b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement <b>Indian Scenario of IPR:</b> 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	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	<b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	07



	of getting a patent	
05	<b>Patent Rules:</b> 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	<b>Procedure for Filing a Patent (National and International):</b> Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement  <b>Patent databases:</b> Important websites, Searching international databases	07

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

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

**End Semester Theory Examination:**

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

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

**REFERENCE BOOKS:**

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dufield, 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, 7<sup>th</sup> Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> 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
<b>ILO8028</b>	<b>Digital Business Management</b>	<b>03</b>

**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

<b>Module</b>	<b>Detailed content</b>	<b>Hours</b>
1	<p><b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy,</p> <p><b>Drivers of digital business-</b> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p>	09
2	<p><b>Overview of E-Commerce</b></p> <p><b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>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</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p> <p>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</p>	06

3	<p><b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Tope Apps, Information and referral system</p> <p><b>Application Development:</b> Building Digital business Applications and Infrastructure</p>	06
4	<p><b>Managing E-Business-</b>Managing Knowledge, Management skills for e-business, Managing Risks in e –business</p> <p>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</p>	06
5	<p><b>E-Business Strategy-</b>E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy,</p> <p>E-business strategy into Action, challenges and E-Transition</p> <p>(Process of Digital Transformation)</p>	04
6	<p><b>Materializing e-business: From Idea to Realization-</b>Business plan preparation</p> <p><b>Case Studies and presentations</b></p>	08

### Assessment:

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

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

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

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

## References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6<sup>th</sup> 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, 2<sup>nd</sup> Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vincenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en) OECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

**Objectives:**

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

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

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities.  Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency.  Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

## **Assessment:**

### **Internal:**

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

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

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

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

### **REFERENCES:**

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing, 2015

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 801	Internet of Things Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXL 801	Internet of Things Laboratory	-	-	-	-	25	--	25	50	

**Course Objectives:**

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

**Suggested Experiments:**

**( Programming using C, Embedded C, Python is to be encouraged)**

1. Minimum two Experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for data handling and storage.
2. Minimum three experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for interfacing various sensors and communicating data using Internet using various Protocols.
3. Minimum two experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) and wireless communication protocol (802.11 and 802.14.5 IEEE standard)
4. Minimum one experiment using Cloud Storage.

**Suggested topics for Case Study:**

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.



Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 802	Analog and Mixed VLSI Design	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 802	Analog and Mixed VLSI Design	-	-	-	-	25	--	25	50

**Course Objectives:**

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

**Suggested Experiments:**

- Use of Online Tools to study analog VLSI circuits
2. Analysis of MOSFETs for analog performance
  3. Design and simulate various types of current mirror circuits
  4. Design and simulate various common source amplifier circuits
  5. Design and simulate various types of single stage amplifiers
  6. Design and simulate differential amplifier
  7. Design and simulate operational trans-conductance amplifier
  8. Design and simulate switch capacitor circuits
  9. Design and simulate various types of oscillators
  10. Design and simulate mixed mode circuit
  11. Generate layout for the simple and cascode current mirror
  12. Generate layout for common source amplifier
  13. Generate layout for the differential amplifier

14. Generate layout for the Oscillator

15. Generate layout for Phase Detector

**Suggested topics for Case Study:**

Faculty members can suggest topics pertaining above syllabus and ask students to submit proper report covering the latest advances in the field of Mixed VLSI Design.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8041	Advanced Power Electronics Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXDLO 8041	Advanced Power Electronics Lab.	-	-	-	-	25	--	25	50	

**Course Objectives:**

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

**Suggested Experiments:**

1. Single Phase Full Controlled Bridge Rectifier.
2. Speed control of Separately excited DC motor using Armature Voltage Control
3. Speed control of 3-phase Induction Motor using V/F control.
4. Simulation of 3-phase fully controlled Bridge rectifier with R and RL load.
5. Simulation of 1-phase fully controlled Bridge rectifier and study of various parameters.
6. Simulation of 1-phase Inverter and study of various Performance parameters.
7. Simulation of SVM Inverter.
8. Simulation of Closed loop dc-dc converter
9. Study High Frequency Induction heating & Dielectric heating.
10. Study of operation and control of solid state relays.

**Suggested topics for Case Study:**

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8042	MEMS Technology Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Ave. Of Test 1 and Test 2						
ELXDLO 8042	MEMS Technology Lab.	-	-	-	-	25	--	25	50	

**Course Objectives:**

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

**Suggested Experiments:**

1. Design electro-statically actuated cantilever
2. Design bimorph cantilever which act as pressure sensor.
3. Dynamic analysis of Beam
4. Find the tip deflection of the cantilever with different types of load
5. Find the tip deflection of the cantilever in sweep analysis
6. Model and simulate Electro-mechanical actuator. Do dc and transient analysis
7. Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature
8. Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam
9. Model and simulate of accelerometer
10. Case study of MEMS based device

**Suggested topics for Case Study:**

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices.

Course Code	Course Name	Teaching Scheme			Credits Assigned				
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total	
ELXDL O8043	Virtual Instrumentation Laboratory	--	02	--	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	Exam				
ELXDL O8043	Virtual Instrumentation Laboratory	--	--	--	--	25	25	50	

**Term Work :-**

At least 6 experiments covering entire syllabus of ELXDLO8043 (Virtual Instrumentation) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Virtual Instrumentation need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

**Suggested List of Experiments :-**

1. Verification of arithmetic operations
2. Verification of Boolean Expressions / half-adder & full-adder
3. Implementation of array functions
4. Program to convert Celsius into Fahrenheit & vice-versa
5. Program for implementing seven segment display
6. Program for calculating body mass index (BMI) using cluster

7. Program to control temperature using thermistor / RTD & DAQ
8. Program to control liquid flow using DAQ
9. Program to control liquid level using DAQ
10. Program to control pressure using DAQ
11. Program for DC motor speed control using PID toolbox

Course Code	Course Name	Teaching Scheme			Credits Assigned				
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total	
ELXDL O8044	Digital Image Processing	--	02	--	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	Exam				
ELXDL O8044	Digital Image Processing	--	--	--	--	25	25	50	

### **Term Work :-**

At least 7 experiments covering entire syllabus of ELXDLO8044 (Digital Image Processing) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Digital Image Processing need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.



Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL704	Project I	-	06	--	-	03	--	09
ELXL803	Project II		12			06		

**Objectives:**

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research Outcomes

**Outcome:**

Learner will be able to:

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution is to be validated with proper justification and the report needs to be compiled in standard format.

**Guidelines for Assessment of Project I**

Project I should be assessed based on following points

- a) Quality of problem selected
- b) Clarity of Problem definition and Feasibility of problem solution
- c) Relevance to the specialization
- d) Clarity of objective and scope
- e) Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

**Guidelines for Assessment of Project II**

Project II should be assessed based on following points

- a) Quality of problem selected
- b) Clarity of Problem definition and Feasibility of problem solution
- c) Relevance to the specialization / Industrial trends
- d) Clarity of objective and scope
- e) Quality of work attempted
- f) Validation of results
- g) Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai Students should be motivated to publish a paper in Conferences/students competitions based on the work