**AC No: 2/2022, 11th July 2022**
**Item No. – 6.60 (R)**

# University of Mumbai

**Revised Syllabus for**

# Master of Engineering (ME)

**Course: Electronics Engineering**

**Semester – (I to IV)**

**(Choice Based Credit System)**

**(With effect from the academic year 2022-23)**

# University of Mumbai

| | |
|---|---|
| **O: _____ Title of Course** | M.E. (Electronics Engineering) |
| **O: 5134 Eligibility** | Passed<br>B E/ B Tech (Electronics Engg.);<br>B E/ B Tech (Electronics and Telecommunication Engg.);<br>BE( Electrical and Electronics Engg);<br>BE(Electronics and Computer Science) |
| **R: _____ Passing Marks** | 45% |
| **No. of years/Semesters:** | 2 Years / 4 Semester |
| **Level:** | P.G. / ~~U.G./~~ ~~Diploma / Certificate~~ |
| **Pattern:** | ~~Yearly~~ / Semester |
| **Status:** | ~~New~~ / Revised 2019 'C' |
| **To be implemented from Academic Year:** | With effect from Academic Year : 2022-23 |

**Dr. R N Awale**
**Chairman**
of Ad-hoc Board of Studies in Electronics Engineering

**Dr. Suresh K. Ukarande**
**Associate Dean**,
Faculty of Science and Technology

**Dr Anuradha Majumdar**
**Dean**,
Faculty of Science and Technology

# Preamble

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

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for M E (Electronics Engineering) course from the academic year 2022-23.

**Signature:**

**R N Awale**
**Chairman, Board of Studies**

**Signature:**

**Faculty of Dean**

# Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

**Signature:** **Signature:**

**Chairman, Board of Studies** **Faculty of Dean**

# Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in to-to. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of M E (Electronics Engineering) curriculum to be implemented from academic year 2022-23. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA).

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the student fraternity in multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

**Boards of Studies in Electronics Engineering**

| Sr. No. | Name | Designation | Sr. No. | Name | Designation |
|---|---|---|---|---|---|
| 1 | Dr. R. N. Awale | Chairman | 5 | Dr. Rajani Mangala | Member |
| 2 | Dr. Jyothi Digge | Member | 6 | Dr. Vikas Gupta | Member |
| 3 | Dr. V. A. Vyawahare | Member | 7 | Dr. D. J. Pete | Member |
| 4 | Dr. Srija Unnikrishnan | Member | 8 | Dr. Vivek Agarwal | Member |

**Program Structure for ME Electronics Engineering**

# UNIVERSITY OF MUMBAI

**(With Effect from 2022-2023)**

## Semester - I

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXC1011 | Advanced Digital Communication | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXC1012 | Advanced VLSI Design | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXC1013 | Power Electronics System Design | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXDLO101X | Department Level Optional Course-I | 03 | --- | --- | 03 | --- | --- | 03 |
| ILO101X | Institute Level Optional Course-I | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXL1011 | Laboratory-I Power Electronics System Design | --- | 02 | --- | --- | 01 | --- | 01 |
| ELXL1012 | Laboratory-II Advanced VLSI Design | --- | 02 | --- | --- | 01 | --- | 01 |
| **TOTAL** | | ***15*** | ***04*** | **---** | ***15*** | ***02*** | **---** | ***17*** |

| Course Code | Course Name | EXAMINATION SCHEME–SEMESTER I | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | | | MAXIMUM MARKS | | |
| | | IA | | | ESE (Marks) | Exam Duration (Hours) | | | |
| | | Test I | Test II | Avg. | | | Term Work | Practical / Oral | Total |
| ELXC1011 | Advanced Digital Communication | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXC1012 | Advanced VLSI Design | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXC1013 | Power Electronics System Design | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXDLO101X | Department Level Optional Course-I | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ILO101X | Institute Level Optional Course-I | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXL1011 | Laboratory-I Power Electronics System Design | --- | --- | --- | --- | --- | 25 | 25 | 50 |
| ELXL1012 | Laboratory-II Advanced VLSI Design | --- | --- | --- | --- | --- | 25 | 25 | 50 |
| **TOTAL** | | **100** | **100** | **100** | **400** | **---** | **50** | **50** | **600** |

| Course Code | Department Level Optional Course-I (ELXDLO101X) |
|---|---|
| ELXDLO1011 | Advanced Processor Architecture-I |
| ELXDLO1012 | Next Generation Artificial Intelligence and Machine Learning |
| ELXDLO1013 | Microelectronics Devices |
| ELXDLO1014 | Advanced Digital Image Processing |

| Course Code | Institute Level Optional Course-I (ILO101X) |
|---|---|
| ILO1011 | Product Life cycle Management |
| ILO1012 | Reliability Engineering |
| ILO1013 | Management Information System |
| ILO1014 | Design of Experiments |
| ILO1015 | Operation Research |
| ILO1016 | Cyber Security and Laws |
| ILO1017 | Disaster Management and Mitigation Measures |
| ILO1018 | Energy Audit and Management |

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXC1011 | Advanced Digital Communication | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| ELXC1011 | Advanced Digital Communication | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Pre-requisites:-**

Digital Communication Course

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **Review of Random Processes** | **06** |
| | **1.1** | Definition of random process | |
| | **1.2** | Specifying random process, Examples of discrete time and continuous time random processes | |
| | **1.3** | Stationary random process .Time Averages of random processes | |
| **2** | | **Error Control Coding** | **08** |
| | **2.1** | Concept of Convolutional codes and its representation, transfer function, Convolutional Interleaving, Decoding of Convolutional codes (Viterbi decoding), and their performance in communication systems. | |
| | **2.2** | Turbo codes:-concepts, log-likelihood algebra, product code. | |
| | **2.3** | Low-density Parity-check codes:-construction, minimum distance of LDPC codes | |
| **3** | | **Signaling over Band limited channel** | **08** |
| | **3.1** | Optimum receiver for channels with ISI and AWGN, Optimum maximum likelihood receiver, discrete time model for a channel with ISI. | |
| | **3.2** | Linear Equalization: Peak distortion criteria, mean square error criterion , Performance characteristics of MSE equalizer. Decision feedback equalization: Co-efficient optimization, performance characteristics of Decision feedback equalizer. | |
| **4** | | **Adaptive Equalizer** | **05** |
| | **4.1** | Adaptive linear Equalizer:-Zero forcing algorithm, LMS algorithm, convergence properties of LMS algorithm. | |
| | **4.2** | Self recovering (Blind) equalization based on maximum likelihood criterion. | |
| **5** | | **Signalling over fading channels** | **12** |
| | **5.1** | Channel model for Time variant multipath channels, classification of multipath channels, Signal design for fading multipath channels. Performance Improvement through signal diversity, Rake receiver and multipath diversity, recombining techniques.. | |
| | **5.2** | MIMO systems- Basic considerations, Channel Models for Multiple antenna system, signal transmission through slow fading frequency nonselective and frequency selective MIMO Channels. | |
| | **5.3** | Multiple access techniques: TDMA, FDMA, CDMA, Multichannel Digital Communication in AWGN Channels., OFDM modulation and demodulation in an OFDM system, Spectral Characteristics of Multicarrier signals, Bit and Power allocation in Multicarrier modulation, Peak to Average ratio in multicarrier modulation. | |
| | | **Total** | **39** |

**Text Books:**

1. Simon Haykin, “Digital Communication Systems”, Wiley 2014
2. Bernard Sklar, “Digital Communications: Fundamentals & Applications”, Pearson Education 2nd Ed.

**Reference Books:**

1. John Proakis & Masoud Salehi , “Digital Communication”, McGraw-Hill Education, 5th Ed
2. Simon Haykin “Adaptive Filter Theory”, Prentice Hall Publication 4th Ed.

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

| Course Code | Course Name | Teaching Scheme (Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXC1012 | Advanced VLSI Design | 03 | --- | --- | 03 | --- | --- | 03 |

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

**Course Pre-requisites:-**

1. VLSI Design
2. IC Technology
3. Analog and Mixed Signal VLSI Design

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Topics | Hrs. |
|---|---|---|
| 01 | **Analog and discrete-time signal processing** | **03** |
| | Mixed-Signal Layout Issues, *Floor-planning*, *Power Supply and Grounding Issues, Guard Rings* | |
| 02 | **Analog integrated continuous-time and discrete-time filters** | **08** |
| | MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator, Analog multipliers, Loop Filters, Switched Capacitor filter | |
| 03 | **Special-purpose CMOS circuits.** | **08** |
| | Schmitt trigger, Multi-vibrator Circuits, Ring oscillators, VCO , Voltage Generators | |
| 04 | **Data Converters** | **08** |
| | Basics of Analog to digital converters (ADC) Basics of Digital to analog converters (DAC) DACs Successive approximation ADCs Dual slope ADCs High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures) High-resolution ADCs (e.g. delta-sigma converters) | |
| 05 | **Memory** | **06** |
| | ROM, EPROM, F-N model, RAM Memory structure Array Design, sensing and operation of memory cell. | |
| 06 | **Phase Lock Loop** | **06** |
| | Mixed-Signal layout Interconnects Phase locked loops Delay locked loops. Simple PLL, Charge pump PLL, Non ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits | |
| **TOTAL** | | **39** |

**Reference Books:-**


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

**Research Publication:-**


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


**Internal Assessment (IA):**

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

**End Semester Examination:**

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

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXC1013 | Power Electronics System Design | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| ELXC1013 | Power Electronics System Design | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Objectives:**

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

**Course Outcomes:**

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

1. **Understand** power semiconductor device structures for adjustable speed motor control applications.
2. **Apply** the concepts of mathematical modelling and computer simulations to power electronic systems.
3. **Design** the new topologies of DC-AC inverters like multi-level and 4-leg inverters.
4. **Interpret** various issues involved in the parallel operation of inverters as a part of distributed generation system.
5. **Select** appropriate three phase AC voltage controllers depending on the application.
6. **Analyze** vital role played by power electronic converters in distributed generation and smart grids.

**Note:** The action verbs according to Bloom's taxonomy are highlighted in bold.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Analysis of Power Devices** | 05 |
| | 1.1 | Power MOSFET, SCR, IGBT, selection criteria for switching devices | |
| | 1.2 | EMI-EMC issues, protection circuits: Anti saturation protection for IGBT and power MOSFET, overload protection, thermal protection. | |
| 2 | | **Simulation of Power Electronic Converters and Systems** | 6 |
| | 2.1 | Introduction to circuit oriented simulators like SPICE, MATLAB, SCILAB, comparison of these simulators | |
| | 2.2 | Study of transformations from 3-phase to stationary reference frame (Clarke transform) and rotating reference frame, decoupled closed-loop control strategies for converters based on these transformations. | |
| 3 | | **Modelling and Control of Power Electronic Systems** | 08 |
| | 3.1 | Concept of zero-order hold (ZOH), first-order hold (FOH) and second-order hold (SOH) elements, energy factor, models of AC-DC, DC-AC, AC-AC and DC-DC converters as simple ZOH, FOH and SOH | |
| | 3.2 | PI control for AC-DC converters, PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis. | |
| 4 | | **Inverters (DC-AC Converters)** | 10 |
| | 4.1 | Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques) | |
| | 4.2 | Study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters: droop, and master & slave control. | |
| 5 | 5.1 | **Three phase AC Voltage Controllers** | 4 |
| | | Three-phase full wave controller with R, RL-load, Input power factor, static switches. | |
| 6 | | **Grid Interface of Renewable Energy Sources** | 6 |
| | 6.1 | Inverter interfacing control strategies for transferring wind and solar energy to grid, synchronization with grid using phase-locked loop | |
| | 6.2 | Concept of distributed generation systems, micro grids, smart grids. | |
| **Total** | | | 39 |

**Text Books:**


1. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.
2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.
3. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer USA, 2001.
4. F. L. Luo, H. Ye, M. H. Rashid, Digital Power Electronics and Applications, Elsevier Academic Press, USA, 2005.
5. H. Akagi, E. H. Watanabe, M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press/John Wiley & Sons Ltd., USA, 2007.
6. B. K. Bose, Modern power electronics and AC drives, Prentice Hall PTR, 2002.

**Reference Books/ Research papers:**


1. Q.-C. Zhong, T. Hornik, Control of Power Inverters in Renewable Energy And Smart Grid Integration, IEEE Press/John Wiley & Sons, Ltd., USA, 2013.
2. J.-S. Lai and F. Z. Peng, Multilevel converters – A new breed of power converters, IEEE Transactions on Industry Applications, vol. 32, no. 3, pp. 509-517, May/Jun 1996. URL:http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=502161&isnumber=10824
3. T. Kawabata and S. Higashino, Parallel operation of voltage source inverters, IEEE Transactions on Industry Applications, vol. 24, no. 2, pp. 281–287, 1988. URL: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=2868&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel1%2F28%2F164%2F00002868
4. W. C. Lee, T. K. Lee, S. H. Lee, K. H. Kim, D. S. Hyun, and I. Y. Suh, A master and slave control strategy for parallel operation of three-phase UPS systems with different ratings, Proceedings of the 19th Annual IEEE Applied Power Electronics Conference & Exposition, (Anaheim, California, USA), pp. 456–462, Feb. 2004. URL: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1295848&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F9082%2F28818%2F01295848.pdf%3Farnumber%3D1295848


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

| Course Code | Course Name | Teaching Scheme (Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXDLO1011 | Advanced Processor Architectures-I | 03 | --- | --- | 03 | --- | --- | 03 |

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

**Course Pre-requisites:-**

1. Computer Organization

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Unit No. | Topics | Hrs |
|---|---|---|---|
| 1 | | **Performance Metrics** | **03** |
| | 1.1 | Processor performance equation | |
| | 1.2 | Energy and power within a microprocessor and power-reduction techniques | |
| | 1.3 | Designing for increasing performance of a Computer | |
| 2 | | **X86 Protection Mechanism** | **08** |
| | 2.1 | Protected mode register set | |
| | 2.2 | Segmentation in protected mode, Segment Descriptors | |
| | 2.3 | Virtual memory management, Address Translation | |
| | 2.4 | Privilege levels, Protection rules, Descriptors | |
| | 2.5 | Multi-tasking and task switching mechanisms | |
| 3 | | **Architectural Enhancements** | **08** |
| | 3.1 | CISC and RISC processors | |
| | 3.2 | Pipelined processors | |
| | 3.3 | Superscalar Architectures | |
| | 3.4 | Out-of-Order Execution | |
| | 3.5 | VLIW processors | |
| 4 | | **Case Study on the Pentium processor** | **08** |
| | 4.1 | Architecture | |
| | 4.2 | Register Organization | |
| | 4.3 | Instruction pairing, Split-line access mechanism | |
| | 4.4 | Branch Prediction logic | |
| | 4.5 | On-chip cache organizations, Write-Once policy, Cache coherence | |
| 5 | | **Pipelining concepts** | **06** |
| | 5.1 | Pipeline performance | |
| | 5.2 | Arithmetic pipelines | |
| | 5.3 | Hazards, Detection logic and minimization techniques | |
| | 5.4 | Dynamic Instruction scheduling | |
| 6 | | **Parallelism** | **06** |
| | 6.1 | Amdahl's law | |
| | 6.2 | Instruction-level parallelism (ILP), Thread-level parallelism (TLP) | |
| | 6.3 | Symmetric multi-processors(SMP),Multi-threading | |
| | 6.4 | Multi-processor Organizations, Multi-core processors (CMP) | |
| | 6.5 | Clusters, Non-Uniform memory access (NUMA), Graphic processing units(GPU) | |
| **TOTAL** | | | **39** |

**Reference Books:-**


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

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

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

4. Don Anderson, Tom Shanley, Pentium Processor System Architecture, Second Edition, Mind shareInc.

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

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


**Research Publications:-**


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

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


**Internal Assessment (IA) :-**

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

**End Semester Examination:-**

1. Question paper will comprise of 6 questions, each of 20marks.
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 5marks will be asked.
4. Remaining questions will be selected from all the modules.

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXDLO1012 | Next Generation Artificial Intelligence and Machine Learning | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXDLO1012 | Next Generation Artificial Intelligence and Machine Learning | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Learning Objectives:** This course will enable students to:

1. Demonstrate the fundamentals of Intelligent Agents
2. Illustrate the reasoning on Uncertain Knowledge
3. Explore the explanation-based learning in solving AI problems
4. Demonstrate the fundamentals of GDT
5. Illustrate the use of KNN
6. Analyze Recommender System

**Course Outcomes:** The student will be able to:

1. Demonstrate the fundamentals of Intelligent Agents
2. Illustrate the reasoning on Uncertain Knowledge
3. Explore the explanation-based learning in solving AI problems
4. Apply effectively ML algorithms to solve real world problems.
5. Apply Instant based techniques and derive effectively learning rules to real world problems

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Intelligent Agents** | 08 |
| | **1.1** | Agents and Environments, Good Behaviour: The Concept of Rationality | |
| | **1.2** | The Nature of Environments | |
| | **1.3** | The Structure of Agents | |
| | | **T1: Chapter 2, Chapter 5 (2.1 to 2.4, 5.1 to 5.6)** | |
| 2 | | **Uncertain knowledge and Reasoning** | 08 |
| | **2.1** | Quantifying Uncertainty, Acting under Uncertainty | |
| | **2.2** | Basic Probability Notation, Inference Using Full Joint Distributions | |
| | **2.3** | Independence, Bayes'Rule and Its Use the WumpusWorld Revisited | |
| | | **T1: Chapter 13** | |
| 3 | | **Perception** | 07 |
| | **3.1** | Image Formation, Early Image-Processing Operation | |
| | **3.2** | Object Recognition by Appearance, Reconstructing the 3DWorld. | |
| | **3.3** | Object Recognition from Structural Information, Using Vision | |
| | | **T1: Chapter 24** | |
| 4 | | **Advanced Machine Learning** | 08 |
| | **4.1** | Overview, Gradient Descent algorithm, Scikit-learn library for ML, Advanced Regression models, Advanced ML algorithms, KNN, ensemble methods. | |
| | **4.2** | **Forecasting:** Overview, components, moving average, decomposing time series, auto- regressive Models. | |
| | **4.3** | **CLUSTERING**: Types of clustering, Partitioning methods of clustering (k-means, k-medoids), hierarchical methods | |
| | | **T2: Chapter 6 (up to 6.5.4), T3: Chapter 13** | |
| 5 | | **Recommender System:** | 08 |
| | **5.1** | Datasets, Association rules, Collaborative filtering, User-based similarity, item-based similarity, using surprise library, Matrix factorization | |
| | **5.2** | **Text Analytics:** Overview, Sentiment Classification, Naïve Bayes model for sentiment classification, using TF-IDF vectorizer, Challenges of text analytics | |
| | | **T2: Chapter 9 and** 10 | |
| | | **Total** | **39** |

**Text Books:**

1. Artificial Intelligence, A Modern Approach, Stuart J. Russell and Peter Norvig, Third Edition, Pearson, 2010
2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
3. Tom M. Mitchell, Machine Learning, McGraw-Hill Education, 2013
4. Machine Learning using Python, Manaranjan Pradhan, U Dinesh Kumar, Wiley 2019 T3.
5. Machine Learning, Anuradha Srinivasaraghavan, Vincy Joeph, Wiley 2019

.

**Reference Books:**

1. An Introduction to Multi Agent Systems, Michael Wooldridge, Second Edition, John Wiley & Sons
2. Ethem Alpaydin, Introduction to Machine Learning, PHI Learning Pvt. Ltd, 2nd Ed., 2013
3. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer, 1st edition, 2001
4. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson,2020

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

| Course Code | Course Name | Teaching Scheme (Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXDLO1013 | Microelectronics Devices | 03 | --- | --- | 03 | --- | --- | 03 |

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

**Course Pre-requisites:-**

- Electronic devices: Operation and Characteristics

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| 1 | **Basic Semiconductor Physics** | | 08 |
| | 1.1 | Review of quantum mechanics, | |
| | 1.2 | Electrons in periodic lattices, Ek diagrams, Quasi-particles in semiconductors, electrons, holes and phonons | |
| | 1.3 | Boltzmann transport equation and solution in the presence of low electric and magnetic fields - mobility and diffusivity | |
| 2 | **Semiconductor Junction** | | 08 |
| | 2.1 | p-n junction action, Abrupt junction, Linearly graded junction, Static IV Characteristics of p-n junction, Electrical breakdown in p-n junctions | |
| | 2.2 | Dynamic behaviour of p-n junction diode | |
| | 2.3 | Majority carrier diodes | |
| | 2.4 | Schottky, homo- and hetero-junction band diagrams and I-V characteristics | |
| 3 | **Modeling Bipolar Device Phenomena** | | 05 |
| | 3.1 | Injection and Transport Model | |
| | 3.2 | Continuity Equation | |
| | 3.3 | Transistor Models: Ebers - Moll and Gummel Poon Model | |
| | 3.4 | SPICE modeling, temperature and area effects | |
| 4 | **MOSFET Modeling** | | 08 |
| | 4.1 | Introduction, Inversion Layer, | |
| | 4.2 | Threshold Voltage | |
| | 4.3 | Gradual Channel Approximation, MOS Transistor Current | |
| | 4.4 | Temperature, Short channel and Narrow Width Effect | |
| | 4.5 | Characterization of MOS capacitors: HF and LF CVs | |
| | 4.6 | Models for Enhancement, Depletion Type MOSFET | |
| 5 | **Modeling of Hetero Junction Devices** | | 06 |
| | 5.1 | Band gap Engineering | |
| | 5.2 | Band gap Offset at abrupt Hetero-junction | |
| | 5.3 | Modified current continuity equations | |
| | 5.4 | Hetero Junction bipolar transistors (HBTs), Si-Ge | |
| 6 | **Monte Carlo Particle Modeling of Semiconductor Devices** | | 04 |
| | 6.1 | The Monte Carlo method | |
| | 6.2 | Application of Monte Carlo techniques to device modeling | |
| **TOTAL** | **39** | | |

**Reference Books:-**


1. M. S. Tyagi, “Introduction to Semiconductor Materials and Device”, John Wiley & sons, 1991
2. Ben G. Streetman & S. K. Bannerjee, ”Solid State Electronic Devices” 6th edition, Prentice Hall
3. Richard S. Muller & Theodore I. Kummins, “Device Electronics for Integrated Circuits”, John Wiley & Sons, 2nd edition (1986)
4. A. S. Grove, “Physics & Technology for Semiconductor Devices”, McGraw Hill, 3rd edition (2007)
5. Donald A. Neamen, “Semiconductor Devices & Physics”, McGraw Hill, 3rd edition (2007)
6. M. H. Rashid, “SPICE for Circuits & Electronics”, Prentice Hall (1995)
7. A. Vladimirescu, “The SPICE Book”, John Wiley & Sons, New York (1994)


**Research Publications:-**


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

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


**Internal Assessment (IA):**

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

**End Semester Examination:**

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

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXDLO1014 | Advanced Digital Image Processing | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| ELXDLO1014 | Advanced Digital Image Processing | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Pre-requisite**: Digital Image processing

**Course Objectives:**

1. To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
2. To understand the image segmentation and representation techniques.
3. To understand how image are analyzed to extract features of interest.
4. To introduce the concepts of image registration and image fusion.
5. To analyze the constraints in image processing when dealing with 3D data sets.

**Course Outcomes**:

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

1. **Understand** digital image processing fundamentals: hardware and software, digitization, enhancement and restoration, encoding, segmentation, feature detection.
2. **Explain** spatial domain and frequency domain techniques for digital image enhancement.
3. **Perform** segmentation and morphological operations.
4. **Conduc**t independent study and analysis of feature extraction techniques.
5. **Understand** the concepts of image registration and image fusion.
6. **Analyze** the constraints in image processing when dealing with 3D data sets and to apply image processing algorithms in practical applications.

**Note**: The action verbs according to Bloom's taxonomy are highlighted in bold.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **FUNDAMENTALS OF DIGITAL IMAGE PROCESSING** | 06 |
| | 1.1 | Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD | |
| | 1.2 | Image enhancement in spatial and frequency domain, Review of morphological image processing | |
| 2 | | **PRE-PROCESSING, SEGMENTATION AND MODELLING OF IMAGES** | 06 |
| | 2.1 | Pre-processing of images- Histogram equalization Stochastic presentation of images- Stationary and Non-stationary models - Gaussian- HMM - Edge and texture models.. | |
| | 2.2 | Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods | |
| 3 | | **FEATURE EXTRACTION** | 08 |
| | 3.1 | First and second order edge detection operators, Phase congruency, Localized feature extraction-detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, Wavelet features | |
| 4 | | **REGISTRATION AND IMAGE FUSION** | 10 |
| | 4.1 | Registration- Pre-processing, Feature selection-points, lines, regions and templates Feature correspondence-Point pattern matching, Line matching, region matching Template matching | |
| | 4.2 | Transformation functions-Similarity transformation and Affine Transformation. Resampling-Nearest Neighbour and Cubic Splines Image Fusion-Overview of image fusion, pixel fusion, Multiresolution based fusion discrete wavelet transform, Curvelet transform. Region based fusion. | |
| 5 | | **3D IMAGE VISUALIZATION** | 09 |
| | 5.1 | Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes. | |
| | 5.2 | The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.. | |
| | | **Total** | 39 |

**Text Books:**


1. John C.Russ, "The Image Processing Handbook", CRC Press, 2007.
2. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press, 2008.
3. Ardeshir Goshtasby, "2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.

**Reference Books:**

1. Rafael C. Gonzalez, Richard E. Woods, , Digital Image Processing', Pearson,Education, Inc., Second Edition, 2004.
2. Anil K. Jain, Fundamentals of Digital Image Processing', Pearson Education,Inc., 2002.
3. Rick S.Blum,Zheng Liu,“ Multisensor image fusion and its Applications“,Taylor & Francis, 2006.

**Internal Assessment (IA):**

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

**End Semester Examination:**

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

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1011 | Product Lifecycle Management (abbreviated as PLM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1011 | Product Lifecycle Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | 1. To familiarize the students with the need, benefits and components of PLM<br>2. To acquaint students with Product Data Management & PLM strategies<br>3. To give insights into new product development program and guidelines for designing and developing a product<br>4. To familiarize the students with Virtual Product Development |
| **Course Outcomes** | Student will be able to…<br><br>1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.<br>2. Illustrate various approaches and techniques for designing and developing products.<br>3. Apply product engineering guidelines/ thumb rules in designing products for moulding, machining, sheet metal working etc.<br>4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications<br>**PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM | **12** |
| 2 | Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process | **09** |
| 3 | Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation | **06** |
| 4 | Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies | **06** |
| 5 | Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design | **06** |
| 6 | Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis | **06** |

**Reference Books:**

1. John Stark, —Product Lifecycle Management: Paradigm for 21st Century Product Realisation‖, Springer-Verlag, 2004. ISBN: 1852338105

2. Fabio Giudice, Guido La Rosa, Antonino Risitano, —Product Design for the environment-A life cycle approach‖, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, —Product Life Cycle Management‖, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, —Product Lifecycle Management: Driving the next generation of lean thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636265

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1012 | Reliability Engineering (abbreviated as RE) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1012 | Reliability Engineering | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with various aspects of probability theory<br>• To acquaint the students with reliability and its concepts<br>• To introduce the students to methods of estimating the system reliability of simple and complex systems<br>• To understand the various aspects of Maintainability, Availability and FMEA procedure |
| **Course Outcomes** | Student will be able to…<br>1. Understand and apply the concept of Probability to engineering problems<br>2. Apply various reliability concepts to calculate different reliability parameters<br>3. Estimate the system reliability of simple and complex systems<br>4. Carry out a Failure Mode Effect and Criticality Analysis |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye‘s Theorem.<br>**Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.<br>**Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis. | 10 |
| 2 | **Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.<br>**Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.<br>**Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis. | 10 |
| 3 | **System Reliability**<br>System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. | 05 |
| 4 | **Reliability Improvement**<br>Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method. | 10 |
| 5 | **Maintainability and Availability**<br>System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement.<br>Availability – qualitative aspects. | 05 |
| 6 | **Failure Mode, Effects and Criticality Analysis:**<br>Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis | 05 |

**Books Recommended:**

**Reference Books:**


1. L.S. Srinath, —Reliability Engineering‖, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, —Reliability and Maintainability Engineering‖, Tata McGraw Hill.

3. B.S. Dhillion, C. Singh, —Engineering Reliability‖, John Wiley & Sons, 1980.
4. P.D.T. Conor, —Practical Reliability Engg.‖, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, —Reliability in Engineering Design‖, John Wiley & Sons.
6. Murray R. Spiegel, —Probability and Statistics‖, Tata McGraw-Hill Publishing Co. Ltd.

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1013 | Management Information System (abbreviated as MIS) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1013 | Management Information System | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • The course is blend of Management and Technical field.<br>• Discuss the roles played by information technology in today‘s business and define various technology architectures on which information systems are built<br>• Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage<br>• Identify the basic steps in systems development<br>• Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management<br>• Discuss critical ethical and social issues in information systems |
| **Course Outcomes** | Student will be able to…<br>1. Explain how information systems Transform Business<br>2. Identify the impact information systems have on an organization<br>3. Describe IT infrastructure and its components and its current trends<br>4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making<br>5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS. | 7 |
| 2 | Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.<br>Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results | 9 |
| 3 | Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls | 6 |
| 4 | Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E- commerce – B2B B2C. Mobile commerce. | 7 |
| 5 | Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model. | 6 |
| 6 | Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process.<br>Acquiring Information Systems and Applications: Various System development life cycle models. | 10 |

**Books Recommended:**

**Reference Books:**


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


**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1014 | Design of Experiments (abbreviated as DoE) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1014 | Design of Experiments | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | 1. To understand the issues and principles of Design of Experiments (DOE).<br>2. To list the guidelines for designing experiments.<br>3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization |
| **Course Outcomes** | Student will be able to…<br><br>1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action.<br>2. Apply the methods taught to real life situations.<br>3. Plan, analyze, and interpret the results of experiments |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology. | 6 |
| 2 | **Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit. | 8 |
| 3 | **Two-Level Factorial Designs:** The $2^2$Design, The $2^3$ Design, The General $2^k$ Design, A Single Replicate of the $2^k$Design, The Addition of Center Points to the $2^k$Design, Blocking in the $2^k$Factorial Design, Split-Plot Designs. | 7 |
| 4 | **Two-Level Fractional Factorial Designs:** The One-Half Fraction of the $2^k$ Design, The One-Quarter Fraction of the $2^k$ Design, The General $2^{k-p}$ Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs. | 7 |
| 5 | **Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets. | 7 |
| 6 | **Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples. | 4 |

**Books Recommended:**

**Reference Books:**


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

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1015 | Operation Research (abbreviated as OR) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1015 | Operation Research | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • Formulate a real-world problem as a mathematical programming model.<br>• Understand the mathematical tools that are needed to solve optimization problems.<br>• Use mathematical software to solve the proposed models. |
| **Course Outcomes** | Student will be able to…<br>1. Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.<br>2. Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.<br>3. Perform sensitivity analysis to determine the direction and magnitude of change of a model‘s optimal solution as the data change.<br>4. Solve specialized linear programming problems like the transportation and assignment problems.<br>5. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.<br>6. Understand the applications of, basic methods for, and challenges in integer programming<br>7. Model a dynamic system as a queuing model and compute important performance measures |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Operations Research***:* Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research | 2 |
| 2 | **Linear Programming***:* Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, ***Duality***, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis | 6 |
| 3 | **Transportation Problem***:* Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.<br>**Assignment Problem***:* Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem | 6 |
| 4 | **Integer Programming Problem***:* Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | 6 |
| 5 | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | 6 |
| 6 | **Simulation***:* Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation | 4 |
| 7 | **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo | 4 |
| 8 | **Games Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. | 4 |
| 9 | **Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, | 4 |

**Books Recommended:**

**Reference Books:**


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, Kedar Nath Ram Nath-Meerut.
5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.


**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1016 | Cyber Security and Laws (abbreviated as CSL) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1016 | Cyber Security and Laws | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand and identify different types cyber crime and cyber law<br>• To recognized Indian IT Act 2008 and its latest amendments<br>• To learn various types of security standards compliances |
| **Course Outcomes** | Student will be able to…<br>1. Understand the concept of cyber crime and its effect on outside world<br>2. Interpret and apply IT law in various legal issues<br>3. Distinguish different aspects of cyber law<br>4. Apply Information Security Standards compliance during software design and development |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes. | 4 |
| 2 | **Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé 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 | 10 |
| 3 | Tools and Methods Used in Cyberline: Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft) | 6 |
| 4 | **The Concept of Cyberspace:** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law | 8 |
| 5 | **Indian IT Act.:** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments | 8 |
| 6 | **Information Security Standard compliances**<br>SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI. | 6 |

**Books Recommended:**

**Reference Books:**


1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi

6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional: https://www.sans.org/reading room/whitepapers/compliance/compliance-primer-professionals- 33538

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1017 | Disaster Management and Mitigation Measures (abbreviated as DMMM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1017 | Disaster Management and Mitigation Measures | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand the various types of disaster occurring around the world<br>• To identify extent and damaging capacity of a disaster<br>• To study and understand the means of losses and methods to overcome /minimize it.<br>• To understand role of individual and various organization during and after disaster<br>• To know warning systems, their implementation and based on this to initiate training to a laymen<br>• To understand application of GIS in the field of disaster management<br>• To understand the emergency government response structures before, during and after disaster |
| **Course Outcomes** | Student will be able to…<br>1. Understand natural as well as manmade disaster and their extent and possible effects on the economy.<br>2. Planning of national importance structures based upon the previous history.<br>3. Understand government policies, acts and various organizational structure associated with an emergency.<br>4. Know the simple do‘s and don‘ts in such extreme events and act accordingly |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change. | 03 |
| 2 | Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters: | 06 |
| 3 | Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in 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. disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process. | 06 |
| 4 | Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard. | 06 |
| 5 | Financing R e l i e f Measures: Ways to raise finance for relief expenditure, Role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events. | 09 |
| 6 | Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids. | 06 |

**Books Recommended:**

**Reference Books:**


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


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

**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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO1018 | Energy Audit and Management (abbreviated as EAM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO1018 | Energy Audit and Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand the importance of energy security for sustainable development and the fundamentals of energy conservation.<br>• To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management<br>• To relate the data collected during performance evaluation of systems for identification of energy saving opportunities |
| **Course Outcomes** | Student will be able to…<br>1. To identify and describe present state of energy security and its importance.<br>2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.<br>3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.<br>4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities<br>5. To analyze the data collected during performance evaluation and recommend energy saving measures |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance | 4 |
| 2 | **Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR) | 8 |
| 3 | **Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment's and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.<br>Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives. | 10 |
| 4 | **Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.<br>General fuel economy measures in Boilers and furnaces, Waste heat recovery use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities | 10 |
| 5 | **Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis. | 4 |
| 6 | **Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources | 3 |

**Books Recommended:**

**Reference Books:**


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


**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test 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.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXL1011 | Power Electronics System Design Lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical And Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXL1011 | Power Electronics System Design Lab | - | - | - | - | - | 25 | 25 | 50 |

**Term Work:**
At least 10 experiments covering the entire syllabus of ELXC1013 (**Power Electronics 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. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exams will be based on the entire syllabus.

**Laboratory Outcomes:**

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

1. **Analyze** selection criteria for power switching devices.
2. **Simulate** the power converters using simulation software like MATLAB, SCILAB and PSPICE.
3. **Design** and simulate closed loop control system for power converters.
4. **Simulate** a three phase power converters.
5. **Understand** the application of power electronics system.

**Note:** The action verbs according to Bloom's taxonomy are highlighted in bold.

**Suggested List of Experiments**

| Sr. No. | Experiment Title |
|---|---|
| 1 | To study selection criteria for power switching devices. |
| 2 | To study PSPICE as circuit oriented simulators for power converters. |
| 3 | To study MATLAB as circuit oriented simulators for power converters. |
| 4 | To study SCILAB as circuit oriented simulators for power converters. |
| 5 | To study ZOH, FOH and SOH model of power converters. |
| 6 | To study PI and PID control of power converters. |
| 7 | To study three phase inverter with R, RL load. |
| 8 | To study multilevel inverter topologies. |
| 9 | To study three phase controlled rectifier with R/RL load. |
| 10 | To study grid interface of renewable energy sources. |

**Note:** Experiments can be performed online using simulation software as well as hardware. Free simulation software SCILAB can be used to perform the experiments.

***(Expected percentage of H/w and software experiments should be 60% & 40% respectively)***

***Note:***
***Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.***

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXL1012 | Advanced VLSI Design Lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical And Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXL1012 | Advanced VLSI Design Lab | - | - | - | - | - | 25 | 25 | 50 |

**Suggested List of Experiments (Any six):-**

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

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

**Program Structure for ME Electronics Engineering**

# UNIVERSITY OF MUMBAI

**(With Effect from 2022-2023)**

## Semester - II

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXC2021 | Modern Industrial Internet Engineering | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXC2022 | Emerging Trends in SOC Design | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXC2023 | Advanced Digital Signal Processing | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXDLO202X | Department Level Optional Course II | 03 | --- | --- | 03 | --- | --- | 03 |
| ILO202X | Institute Level Optional Course-II | 03 | --- | --- | 03 | --- | --- | 03 |
| ELXL2021 | Laboratory-III Emerging Trends in SOC Design | --- | 02 | --- | --- | 01 | --- | 01 |
| ELXL2022 | Laboratory-IV Advanced Digital Signal Processing (ADSP) | --- | 02 | --- | --- | 01 | --- | 01 |
| **TOTAL** | | ***15*** | ***04*** | ***---*** | ***15*** | ***02*** | ***---*** | ***17*** |

| Course Code | Course Name | EXAMINATION SCHEME–SEMESTER II | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | | | MAXIMUMMARKS | | |
| | | INTERNAL ASSESSMENT (IA) | | | End Semester Examination (Marks) | Exam Duration (Hours) | | | |
| | | Test I | Test II | Avg. | | | Term Work | Practical / Oral | Total |
| ELXC2021 | Modern Industrial Internet Engineering | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXC2022 | Emerging Trends in SOC Design | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXC2023 | Advanced Digital Signal Processing | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXDLO202X | Department Level Optional Course II | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ILO202X | Institute Level Optional Course-II | 20 | 20 | 20 | 80 | 03 | --- | --- | 100 |
| ELXL2021 | Laboratory-III Emerging Trends in SOC Design | --- | --- | --- | --- | --- | 25 | 25 | 50 |
| ELXL2022 | Laboratory-IV Advanced Digital Signal Processing (ADSP) | --- | --- | --- | --- | --- | 25 | 25 | 50 |
| **TOTAL** | | **100** | **100** | **100** | **400** | **---** | **50** | **50** | **600** |

| Course Code | Department Level Optional Course-II (EXCDLO202X) |
|---|---|
| ELXDLO2021 | Advanced Processor Architecture-II |
| ELXDLO2022 | Cloud Computing |
| ELXDLO2023 | Nanoelectronics |
| ELXDLO2024 | Deep Learning and Computer Vision |

| Course Code | Institute Level Optional Course-II (ILO202X) |
|---|---|
| ILO2021 | Project Management |
| ILO2022 | Finance Management |
| ILO2023 | Entrepreneurship Development and Management |
| ILO2024 | Human Resource Management |
| ILO2025 | Professional Ethics and CSR |
| ILO2026 | Research Methodology |
| ILO2027 | IPR and Patenting |
| ILO2028 | Digital Business Management |
| ILO2029 | Environmental Management |

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXC2021 | Modern Industrial Internet Engineering | 03 | - | - | 03 | - | - | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXC2021 | Modern Industrial Internet Engineering | 20 | 20 | 20 | 80 | 03 | - | - | 100 |

**Pre-Requisites**: Computer Networks, Web Technologies, Industrial Automation.

**Course Objectives:**

1. To understand the importance of the Internet in Industrial applications.
2. To understand various protocols used in modern industry for communication.
3. To learn Internet of Things
4. To analyse IoT functional stack

**Course Outcomes:**

**At the end of this course the student will be able to:**

1. Understand the importance of the Internet in Industrial applications.
2. Compare various communication protocols used in industry.
3. Analyse significance of Industry 4.0
4. Emphasize core IoT functional Stack and understand application protocols for IoT.
5. Define cloud computing and memorize the different cloud service and deployment models.
6. Understand security aspects of IoT

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **Internet Fundamentals and IP versions** | 03 |
| | 1.1 | IPv4 ADDRESSES : Address Space , Classful and Classless addressing. | |
| | 1.2 | IPv6 ADDRESSES: Structure, Address Space, Packet format, Advantages. | |
| | 1.3 | TRANSITION FROM IPv4 TO IPv6 | |
| **2** | | **Industrial Communication Protocols** | 06 |
| | 2.1 | Web Communication Protocols for connected devices:- CoRE Environment, CoAP, M2M, MQTT, XMPP, HTTP, SOAP Protocols | |
| | 2.2 | RS485/RS232 Communication Protocols, MODBUS protocol, | |
| **3** | | **Industry 4.0 and Internet of Things (IoT)** | 08 |
| | 3.1 | IoT Impact – Connected Roadways, Connected Factory, Smart Connected Buildings, Smart Creatures | |
| | 3.2 | Convergence of IT and OT, IoT Challenges | |
| | 3.3 | IoT Data Management and Compute Stack – Design considerations and Data related problems, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud | |
| **4** | | **The Core IoT Functional Stack** | 08 |
| | 4.1 | Layer 1 – Things: Sensors and Actuators Layer | |
| | 4.2 | Layer 2 – Communications Network Layer, Access Network Sublayer, Gateways and Backhaul Sublayer, Network Transport Sublayer, IoT Network Management Sublayer | |
| | 4.3 | Layer 3 – Applications and Analytics Layer, Analytics Vs. Control Applications, Data Vs. Network Analytics, Data Analytics Vs. Business Benefits, Smart Services | |
| **5** | | **Cloud Computing** | 08 |
| | 5.1 | Cloud Computing Paradigm for Data Collection, storage and computing | |
| | 5.2 | Cloud Service Models, Cloud Deployment Models,Cloud computing architecture, Advantages and Disadvantages of Cloud Computing. | |
| **6** | | **Securing IoT** | 06 |
| | 6.1 | Security Priorities : Integrity, Availability and Confidentiality | |
| | 6.2 | Risk Analysis Structures : OCTAVE and FAIR | |
| | | **Total** | **39** |

**Text Books:**

1. B.A. Forouzan, Data Communications and Networking, 4th edition, TMH

2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1 st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.

3. Barrie Sosinsky ,"Cloud Computing Bible",Wiley Publication.

**Reference Books:**

1. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Wiley Publication
2. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (Editor), Springer Publications.

**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 consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the 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 and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXC2022 | Emerging Trends in SOC Design | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXC2022 | Emerging Trends in SOC Design | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Objectives:**

1. To develop the understanding of fundamental principles of System on Chip Design.
2. To disseminate the basic methods for FPGA, ASIC and NOC based design for SOC.
3. To develop the concept of Soft core and Multi-Core Processors.
4. To introduce the design of Processor ASIC and DDR memory controller.

**Course Outcomes:**

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

1. **Understand** the fundamental concepts of SOC design.
2. **Analyze** various SOC designs based on ASIC, FPGA and NOC.
3. **Develop** the concepts of Soft core and Multi core Processors.
4. **Design** various System on Chip Designs using FPGA and ASIC.
5. **Create** SOC designs similar to Processor ASIC and DDR memory controller.

**Note:** The action verbs according to Bloom's taxonomy are highlighted in bold.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Introduction to SoC** | 06 |
| | 1.1 | The Fundamentals trends of SoC, SoC Design Flow, Challenges in SoC Design | |
| | 1.2 | Introduction to Digital SoC Design:<br>Fundamentals of Processor Organizations, Memory Organizations and Interconnect organizations, | |
| | 1.3 | Introduction to Analog SoC Design:<br>System Architecture and Methods, Noise in Mixed Signal Circuits, Inter Symbol Interference | |
| 2 | | **FPGA Based System Design** | 06 |
| | 2.1 | FPGA Based Systems Designs: Goals and Techniques, Hierarchical Design, Design Abstraction, Methodologies | |
| | 2.2 | FPGA Based Architecture: Introduction, Behaviour Design, Design Methodologies | |
| | 2.3 | Large Scale FPGA Systems: Busses, Platform FPGAs, Multi-FPGA Systems, Novel Architectures | |
| 3 | | **ASIC Based System Design** | 08 |
| | 3.1 | ASIC Design Constraints: Synchronous Design Flow, Positive and Negative Clock and impact on speed. Timing Path Design | |
| | 3.2 | Multiple Clock Domain Design: Data Path Synchronizers | |
| | 3.3 | Architecture and Microarchitecture Design: Design Partitioning and Clock Grouping | |
| 4 | | **Soft-core And Multicore Processors** | 10 |
| | 4.1 | Soft-core Processors: Configurable Processors, Instruction Set issues | |
| | 4.2 | Stream Multicore Processors: Raw Architecture Overview, Raw chip Implementation, Stream and ILP Computation | |
| 5 | | **NoC Based Design and IoT** | 07 |
| | 5.1 | NoC with Switch interconnect: Static and Dynamic Networks | |
| | 5.2 | Layered Architecture and Network Interface Unit: NoC Layered Architecture, NoC and NIU Example, Bus versus NoC | |
| | 5.3 | Evaluating Interconnect Networks: Static Versus Dynamic Networks, Comparing Networks Examples | |
| 6 | | **SoC Case Studies** | 02 |
| | 6.1 | Processor ASIC Implementation, DDR memory controller | |
| | 6.2 | ALTERA ARRIA-10 | |
| | | **Total** | 39 |

**Text Books:**


1. Michael J. Flynn, Wayne Luk," Computer System Design: System-On-Chip",Wiley; ISBN: 9781118009901, Edition: 1, June 2011.
2. Vibbhav Taraate, "ASIC Design and Synthesis-RTL Design Using Verilog", Springer, ISBN 978-981-33-4641-3.
3. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization", 2nd Edition, 2000, Addison Wesley Professional.
4. Jari Nurmi, "Processor Design: System-On-Chip Computing for ASICs and FPGAs", Springer, 2007.
5. ALTERA,CYCLONE-V,TERASIC,DE1,XILINX-Zynq-7000,Microchip, polar Fire, Xilinx Virtex Ultrascale, Xilinx Kintex Ultrascale, ALTERA ARRIA-10,


**Reference Books:**


1. Wayne Wolf, "FPGA-Based System Design", Prentice Hall, Modern Semiconductor Design Series, ISBN 0131424610.
2. Xilinx Technical Reference Manual,"Zynq Ultra Scale + Device", UG 1085 (v2.2) December 4, 2020.
3. Ricardo Reis, "Design of System on a Chip: Devices and Components", 1st Edition, 2004, Springer
4. Jason Andrews, "Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)", Newnes, BK and CDROM.
5. Prakash Rashinkar, Peter Paterson and Leena Singh L, "System on Chip Verification – Methodologies and Techniques", 2001, Kluwer Academic Publishers.


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

| Course Code | Course Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXC2023 | Advanced Digital Signal Processing | 3 | - | - | 3 | - | - | 3 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | | | |
| | | Internal assessment | | | End Sem. Exam | Term Work | Practical | Oral | Total |
| | | Test 1 | Test 2 | Avg. Of Test 1 & Test 2 | | | | | |
| ELXC2023 | Advanced Digital Signal Processing | 20 | 20 | 20 | 80 | - | - | - | 100 |

**Course Pre-requisites**:

Signals and Systems, Digital Signal Processing, Probability and Random processes.

**Course Objectives:**

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

**Course Outcomes:**
Students will be able to

**1.** Apply multirate processing techniques in practical applications.
**2.** Design optimum filters suited for different applications.
**3.** Design and simulate adaptive systems.
**4.** Extract information from spectral analysis of signals.
**5.** Design and test signal processing algorithms for various tasks.

| Module No. | Unit No | Topics | Hrs |
|---|---|---|---|
| 01 | | **Introduction and Review** | 04 |
| | 1.1 | Basic DSP examples in block diagrams, Typical DSP in real world applications. | 02 |
| | 1.2 | Review of FIR & IIR filters, Sampling and Reconstruction of signals, Analog to digital and Digital to analog conversions. | 02 |
| 02 | | **Multirate Digital Signal Processing** | 12 |
| | 2.1 | Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D . | 03 |
| | 2.2 | Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion. | 03 |
| | 2.3 | Sampling rate conversion of band pass signal, sampling rate conversion by arbitrary factor, Applications of multirate signal processing. | 03 |
| | 2.4 | Digital filter banks, Two channel Quadrature Mirror filter banks. | 03 |
| 03 | | **Linear Prediction and Optimum filters** | 07 |
| | 3.1 | Random signals, Correlation functions, Power Spectra, Innovations representation of a Stationary random Process | 03 |
| | 3.2 | Forward and Backward Linear predictions. | 02 |
| | 3.3 | Solution of Normal equations. The Levinson-Durbin Algorithm. | 02 |
| 04 | | **Adaptive Digital Filters** | 06 |
| | 4.1 | FIR adaptive filters.<br>Steepest descent adaptive filter, LMS algorithms, Normalized LMS, Application in noise cancellation. | 04 |
| | 4.2 | Adaptive Recursive filters. | 02 |
| 05 | | **Power Spectrum Estimation** | 06 |
| | 5.1 | Estimation of spectra from finite duration observations of signals. | 02 |
| | 5.2 | Nonparametric methods for power spectrum estimation. | 02 |
| | 5.3 | Parametric methods for power spectrum estimation. | 02 |
| 06 | | **Applications of DSP** | 04 |
| | 6.1 | Biomedical applications, ECG signal analysis, QRS template, QRS detection methods etc. | 02 |

| | | | |
|---|---|---|---|
| | 6.2 | Speech processing applications, Wideband and narrowband spectrograms. | 02 |
| | | **Total** | 39 |

**Reference Books:**


1. Digital Signal Processing Principles, algorithms and applications, John. G. Proakis , D.G.Manolakis. 4/e, Pearson.
2. Digital Signal Processing, A Practical approach. Emmanuel .C. Ifeachor B.W.Jervis. Pearson.
3. Digital Signal Processing. A computer based approach, S.K.Mitra, Tata Mc Graw Hill.
4. Statistical Digital Signal Processing, Monson. H .HAYES, Wiley India.
5. Introduction to Digital Speech Processing, L. R Rabiner & R.W Schafer, Pearson.
6. Discrete time Signals Processing, Oppenheim & Schaffer, Pearson.


**Recommended Research Papers for Reading:**


1. **P. Vaidyanathan** (1990). *"Multirate Digital filters, Filter banks, Polyphase network and applications: A tutorial"* Proc. IEEE vol 78, No 1, pp 56-90.
2. **Schoeder M. R** (1985) *"Linear predictive coding of speech: Review and current directions"* IEEE Commun. Mag vol 23 , pp 54-61
3. **Widrow.B**(1975) *"Adaptive noise cancelling, Principles and Applications"* Proc IEEE, vol 63, pp 1692-1716
4. **Widrow B**(1976*) " Stationary and Non stationary characteristics of the LMS adaptive filter"* Proc IEEE , vol 64,pp 1151-1162
5. **Thomson D. J** (1969) *" Spectral estimation & Harmonic analysis"* Proc IEEE vol 70, pp 1055-1096


**Internal Assessment (IA):**

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

**End Semester Examination:**

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

| Subject Code | Course Name | Teaching Scheme (Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXDLO2021 | Advanced System Architectures | 03 | --- | --- | 03 | --- | --- | 03 |

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

**Course Pre-requisites:-**

1. Computer Organization & Processor Architectures

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| 1 | | **Computer Architecture Fundamentals** | 06 |
| | 1.1 | A top Level View of Computer functions and Interconnections | |
| | 1.2 | Computer Components, Architecture organization | |
| | 1.3 | Concepts and Ways of Parallelism | |
| | 1.4 | Domain-Specific Processors and Application Specific Processors | |
| | 1.5 | Design Considerations | |
| 2 | | **Processor Design Flow** | 06 |
| | 2.1 | Capturing requirements, Instruction coding | |
| | 2.2 | Exploration of Architecture Organizations | |
| | 2.3 | Hardware and Software Development | |
| | 2.4 | Software tools and libraries | |
| 3 | | **Memory** | 06 |
| | 3.1 | Semiconductor Memories SRAM, DRAM and organization | |
| | 3.2 | Principles of Cache memory, Cache Design | |
| | 3.3 | Cache Coherency, MESI Protocol | |
| | 3.4 | RAID | |
| 4 | | **I/O, Peripherals and Operating System** | 06 |
| | 4.1 | Types of I/Os, I/O Interfacing concepts | |
| | 4.2 | PCI, PCI-X, PCI-E | |
| | 4.3 | Universal Serial Bus(USB) | |
| | 4.4 | Operating System Overview, Scheduling | |
| | 4.5 | Memory Management in Operating Systems | |
| 5 | | **VLIW DSP Processor** | 07 |
| | 5.1 | DSP Processor Architecture, DSP-specific requirements | |
| | 5.2 | Micro architectural concepts | |
| | 5.3 | VLIW and SW programmability | |
| | 5.4 | Application specific adaptable core Architecture | |
| | 5.5 | Design space Exploration, Complexity of Configurability | |
| 6 | | **Soft-Core Processors** | 08 |
| | 6.1 | Processor Customization | |
| | 6.2 | Microprocessor cores in SOC design, Difference between Microprocessor and SOC | |
| | 6.3 | Reconfigurable processors with FPGA | |
| | 6.4 | Case study of Reconfigurable structure | |
| | 6.5 | Pitfalls in VLIW Architectures | |
| **TOTAL** | | | **39** |

**Reference Books:-**


1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Eighth Edition, Pearson Publications.
2. Jari Nurmi, "Processor Design: System-on-Chip Computing for ASICs and FPGAs", Springer.
3. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.
4. Hennessy JL, Patterson DA (2003) Computer Architecture: A Quantitative Approach.3rd edition. Elsevier Morgan Kaufmann, San Francisco


**Research Publications:-**


1. Andrea Lodi, Mario Toma, "A VLIW Processor with a Reconfigurable Instruction Set for Embedded Applications", IEEE Journal Of Solid-State Circuits, Vol. 38, No. 11, November2003,pp-1876-1886.
2. Lodi A, Cappelli A, Bocchi M, Mucci C, "XiSystem: A XiRisc-based SoC with a Reconfigurable I/O Module", IEEE Journal of Solid-State Circuits (JSSC), 2006, Vol.41, No.1, pp-85–96.


**Internal Assessment (IA):-**

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

**End Semester Examination:-**

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

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/ Practical and Oral | Tutorial | Total |
| ELXDLO2022 | Cloud Computing | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXDLO2022 | Cloud Computing | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Objectives: Students will be able to learn**

1. Basics of cloud computing.
2. Key concepts of virtualization
3. Different cloud computing services
4. Cloud implementation, Programming and Mobile cloud computing
5. Key components of Amazon Web Services
6. Cloud security and privacy

**Course Outcomes:**

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

1. Define cloud computing and memorize the different cloud service and deployment models.
2. Describe importance of virtualization along with their technologies.
3. Use and examine different cloud services.
4. Analyse the components of open stack and Google Cloud platform and understand Mobile Cloud computing.
5. Describe the key components of Amazon web service.
6. Understand cloud security and privacy.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **Introduction to the Cloud Computing** | **08** |
| | **1.1** | Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud, Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing. | |
| | **1.2** | **Virtualization:** Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors, Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization and Cloud Computing, Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV | |
| | | | |
| **2** | 2.1 | **Cloud Computing Services** | 04 |
| | | SPI Model of Cloud computing, Anything as a service or Everything as a Service (XaaS): Database as a Service,Storage as a Service, Security as a Service,Collaboration as a Service, Compliance as a service, Monitoring as a Service, Network as a Service, Disaster Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service. | |
| | | | |
| **3** | 3.1 | **Amazon Web Service Cloud Platform** | **10** |
| | | Introduction to the AWS Cloud, AWS coreservices by categories.<br>Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle.<br>Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier.<br>Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups.<br>CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms.<br>Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types ofNon-relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys. | |
| | | | |
| **4** | **4.1** | **Cloud Implementation, Programming and Mobile Cloud Computing** | **06** |
| | | Open Stack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations. Programming support for Google apps engine-GFS, Bigtables, Chubby.<br>Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing | |
| **5** | **5.1** | **Introduction to Azure app services** | **03** |

| | | | |
|---|---|---|---|
| | | REST essentials, .NET web API essentials, Comparison of AWS services with other cloud services like Azure, Google cloud platform | |
| | | | |
| | **6.1** | **Cloud Security and Privacy** | |
| | | What is security, why is it required in cloud computing, Different types of security in cloud, attacks, and vulnerabilities, IaaS security, PaaS security, SaaS security, trust boundary, Audit and reporting. Introduction to Identity and access Management (IAM), IAM Challenges, IAM<br>Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services.<br>Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud?, Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC). | **08** |
| **6** | | **Total** | **39** |

**Text Books:**


1. Barrie Sosinsky ,"Cloud Computing Bible", Wiley Publication.
2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, "Cloud Computing Black Book", Dreamtech Press.
3. Joe Baron et.al ,"AWS certified solution Architect", Sybex publication
4. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication.


**Internal Assessment (IA):**

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

**End Semester Examination:**

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

| Course Code | Course Name | Teaching Scheme (Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXDLO2023 | Nanoelectronics | 03 | --- | --- | 03 | --- | --- | 03 |

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

**Course Pre-requisites:-**

1. MOSFET & Microelectronic Concepts
2. Quantum Mechanics

**Course Objectives:-**

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

**Course Outcomes:-**

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

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| 1 | | **Classical particles , classical waves and Quantum Particles** | 08 |
| | 1.1 | Introduction to Nanotechnology | |
| | 1.2 | Comparison of classical and Quantum System | |
| | 1.3 | Origins of Quantum Mechanics | |
| | 1.4 | Electron as particle , electron as wave | |
| | 1.5 | Wave packets and uncertainty | |
| 2 | | **Quantum Mechanics of Electron** | 08 |
| | 2.1 | General Postulates of Quantum Mechanics | |
| | 2.2 | Time Independent Schrodinger ‘s equation | |
| | 2.3 | Free electron: One dimensional and three dimensional space, Free electron Gas theory of metals | |
| | 2.5 | Partially confined electron. Finite potential well: Finite potential rectangular well, Parabolic well, Triangular well | |
| | 2.6 | Quantum Dot, Wires and wells | |
| 3 | | **Single Electron and few Electron Phenomena and devices** | 08 |
| | 3.1 | Tunneling junctions and application of tunneling | |
| | 3.2 | Coulomb Blockade and The single Electron Transistor | |
| | 3.3 | Resonant Tunneling Diodes- principle and applications | |
| | 3.4 | Carbon Nanotube Transistor(FETs and SETs), Semiconductor Nanowire FETs and SETs | |
| | 3.5 | Molecular SETs and Molecular Electronics | |
| 4 | | **Model of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots** | 07 |
| | 4.1 | Particles Statistics and density of states | |
| | 4.2 | Semiconductor heterostructures and QuantumWell | |
| | 4.3 | Quantum Wires and Nanowire | |
| | 4.4 | Fabrication Techniques for Nanostructures | |
| 5 | | **Ballistic Transport , and Spin Transport** | 08 |
| | 5.1 | Ballistic Transport: Electron collision and length scale, Ballistic Transport Model ,Quantum Resistance and conductance | |
| | 5.1 | Spin Vs charge, AMR, GMR, TMR , The transport of spin | |
| | 5.2 | Spin devices- Spin valves, Magnetic tunnel junctions, | |
| | 5.3 | Applications – Memories (MRAM, STRAM), Logic device and Microwave Oscillators | |
| **TOTAL** | | | **39** |

**Reference Books:-**


1. George W. Hanson " Fundamental of Nanoelectronics", PEARSON
2. Rainer Waser, "Nano Electronics and Information Technology: Advanced Electronic Materials and Novel Devices", 2nd Edition, Wiley-VCH, 2012.
3. Chonles P. Poole Jr., Frank. J. Owens, "Introduction to Nanotechnology", John Wiley and Sons, 2009.
4. T. Pradeep, "Nano: The essentials", Tata McGraw Hill, 2007.
5. Mark A. Ratner, Danill Ratner, "Nano Technology: A Gentle Introduction to the Next Big Idea", Prentice Hall, 2003
6. Springer Handbook of Nanotechnology ISBN:978-3-540-35172-6


**Research Publications:-**


1. Leland Chang, Yang-Kyu Choi, Daewon Ha, Pushkar Ranade, Shiying Xiong, Jeffrey Bokor, "Extremely Scaled Silicon Nano-CMOS Devices", PROCEEDINGS OF THE IEEE, VOL. 91, NO. 11, NOVEMBER 2003, pp-1860-1873.
2. Thomas Skotnicki, James A. Hutch by, Tsu-Jae King, H.-S. Philip Wong, and Frederic Boeuf, "The End of CMOS Scaling", IEEE CIRCUITS & DEVICES MAGAZINE, January2005,pp-16-26.


**Internal Assessment (IA):**

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

**End Semester Examination:-**

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Q 1 will be compulsory and based on entire syllabus with sub-question of 2-5 marks
4. Remaining questions will be selected from all the modules.

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical and Oral | Tutorial | Theory | TW/Practical and Oral | Tutorial | Total |
| ELXDLO2024 | Deep Learning and Computer Vision | 03 | -- | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical and Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXDLO2024 | Deep Learning and Computer Vision | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |

**Course Objectives:**
By the end of the course, students will be able to

1. Review image processing techniques for computer vision
2. Understand shape, region analysis and will able to detect lines, circles, ellipses.
3. Understand complexity of Deep Learning algorithms and their limitations.
4. Understand modern notions in data analysis oriented computing
5. Chose appropriate algorithms of Deep Learning.
6. Perform experiments in Deep Learning using real-world data.

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

1. Learn the scope of Image processing and Computer Vision
2. Analysis the different image analysis techniques for obtaining features of Image
3. Use Tensor Flow for building and testing deep learning models
4. Interpret the fundamental concepts of artificial neural networks and use of activation functions
5. Design and implement CNN and RNN architectures and use them as per applications
6. Build Deep Learning models in real time applications and interpret the results

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Introduction to Computer Vision:** | 06 |
| | 1.1 | Introduction and history of computer vision, Computer imaging systems, lenses, Image formation and sensing. | |
| | 1.2 | Image analysis, pre-processing, Binary image analysis, thresholding. | |
| 2 | | **Feature Extraction:** | 06 |
| | 2.1 | Edge detection methods and its performance, Hough transform, Segmentation, Morphological filtering, **Fourier transform and convolution.** | |
| | 2.2 | Feature extraction, shape, histogram, color, spectral, texture, Feature analysis, feature vectors. | |
| 3 | | **Introduction to Deep learning:** | 08 |
| | 3.1 | Supervised learning, Unsupervised learning, TensorFlow, Computational Graph theory. | |
| | 3.2 | Regression, Gradient Descent, Tensor Board, Modularity, Sharing Variables, Keras. | |
| 4 | | **Activation Functions:** | 10 |
| | 4.1 | Sigmoid, ReLU, Softmax. | |
| | 4.2 | Artificial Neural Networks : Introduction, Perceptron Training Rule, Gradient Descent Rule. | |
| | 4.3 | Gradient Descent and Backpropagation: Gradient Descent, Stochastic Gradient Descent, Backpropagation algorithm, Examples of ANN | |
| 5 | | **Introduction to Convolutional Neural Networks:** | 09 |
| | 5.1 | Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, CNN applications. | |
| | 5.2 | Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications. | |
| | 5.3 | Deep Learning applications: Image Processing, Speech Recognition, Video Analytics. | |
| | | **Total** | 39 |

**Text Books:**

1. D. H. Ballard & C. M. Brown, "Computer Vision" Prentice Hall
2. "Computer Vision: Algorithms and Applications", Richard Szeliski.
3. Goodfellow, I., Bengio Y., and Courville A., "Deep learning", MIT Press.

**Reference Books:**

1. R. C. Gonzalez & P. Wintz. "Digital Image Processing".
2. Richard Hartley and Andrew Zisserman "Multiple View Geometry in Computer Vision", 2nd edition
3. Aurelien Geron "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow" 2nd 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 consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2021 | Project Management (abbreviated as PM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2021 | Project Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.<br>• To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure. |
| **Course Outcomes** | Student will be able to…<br>1. Apply selection criteria and select an appropriate project from different options.<br>2. Write work break down structure for a project and develop a schedule based on it.<br>3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.<br>4. Use Earned value technique and determine & predict status of the project.<br>5. Capture lessons learned during project phases and document them for future reference |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). | 5 |
| 2 | **Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics. | 6 |
| 3 | **Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). | 8 |
| 4 | **Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks | 6 |
| 5 | **Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.<br>**Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.<br>**Project Contracting** Project procurement management, contracting and outsourcing, | 8 |
| 6 | **Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects.<br>**Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | 6 |

**Books Recommended:**

**Reference Books:**


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


**Assessment:**

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

**End Semester Theory Examination:**

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

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

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2022 | Finance Management (abbreviated as FM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2022 | Finance Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • Overview of Indian financial system, instruments and market<br>• Basic concepts of value of money, returns and risks, corporate finance, working capital and its management<br>• Knowledge about sources of finance, capital structure, dividend policy |
| **Course Outcomes** | Student will be able to…<br><br>1. Understand Indian finance system and corporate finance<br>2. Take investment, finance as well as dividend decisions |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market. **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | 6 |
| 2 | **Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.<br>**Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, | 6 |

| | | |
|---|---|---|
| | and Annuity Due; Continuous Compounding and Continuous Discounting. | |
| 3 | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.<br>**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis. | 9 |
| 4 | **Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | 10 |

**Books Recommended:**
**Reference Books:**


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


**Assessment:**
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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2023 | Entrepreneurship Development and Management (abbreviated as EDM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2023 | Entrepreneurship Development and Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To acquaint with entrepreneurship and management of business<br>• Understand Indian environment for entrepreneurship<br>• Idea of EDP, MSME |
| **Course Outcomes** | Student will be able to…<br>1. Understand the concept of business plan and ownerships<br>2. Interpret key regulations and legal aspects of entrepreneurship in India<br>3. Understand government policies for entrepreneurs |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership<br>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship | 4 |
| 2 | **Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur<br>**Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to | 9 |

| | | |
|---|---|---|
| | Business Operations | |
| 3 | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises | 5 |
| 4 | **Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | 8 |
| 5 | **Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing | 8 |
| 6 | **Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business | 5 |

**Books Recommended:**

**Reference Books:**


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

**Assessment:**

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

**End Semester 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2024 | Human Resource Management (abbreviated as HRM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2024 | Human Resource Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To introduce the students with basic concepts, techniques and practices of the human resource management.<br>• To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective.<br>• To familiarize the students about the latest developments, trends & different aspects of HRM.<br>• To acquaint the student with the importance of behavioral skills, Inter-personal, inter- group in an organizational setting.<br>• To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource |
| **Course Outcomes** | Learner will be able to…<br>1. Gain knowledge and understand the concepts about the different aspects of the human resource management.<br>2. Understand and tackle the changes and challenges in today‘s diverse, dynamic organizational setting and culture.<br>3. Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment.<br>4. Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 05 |
| 2 | **Organizational Behavior (OB) :** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study | 07 |
| 3 | **Organizational Structure & Design:** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 06 |
| 4 | **Human resource Planning:** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods | 05 |
| 5 | **Emerging Trends in HR :** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation. | 06 |
| 6 | **HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM**<br>Role of Strategic HRM in the modern business world, Concept of | 10 |

| | | |
|---|---|---|
| | Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals<br>**Labor Laws & Industrial Relations**<br>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | |

**Books Recommended:**

**Reference Books:**


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


**Assessment:**

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

**End Semester 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2025 | Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2025 | Professional Ethics and Corporate Social Responsibility | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand professional ethics in business<br>• To recognized corporate social responsibility |
| **Course Outcomes** | Student will be able to…<br>1. Understand rights and duties of business<br>2. Distinguish different aspects of corporate social responsibility<br>3. Demonstrate professional ethics<br>4. Understand legal aspects of corporate social responsibility |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business | 04 |
| 2 | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08 |

| | | |
|---|---|---|
| 3 | **Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy<br>**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06 |
| 4 | **Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection.<br>Trajectory of Corporate Social Responsibility in India | 05 |
| 5 | **Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | 08 |
| 6 | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08 |

**Books Recommended:**

**Reference Books:**


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


**Assessment:**

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

**End Semester 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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2026 | Research Methodology (abbreviated as RM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2026 | Research Methodology | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand Research and Research Process<br>• To acquaint students with identifying problems for research and develop research strategies<br>• To familiarize students with the techniques of data collection, analysis of data and interpretation |
| **Course Outcomes** | Student will be able to…<br>1. Prepare a preliminary research design for projects in their subject matter areas<br>2. Accurately collect, analyze and report data<br>3. Present complex data or situations clearly |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | 10 |
| 2 | **Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches | 08 |
| 3 | **Research Design and Sample Design :** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | 08 |

| | | |
|---|---|---|
| 4 | **Research Methodology :** Meaning of Research Methodology, Stages in Scientific Research Process<br>**a.** Identification and Selection of Research Problem<br>**b.** Formulation of Research Problem<br>**c.** Review of Literature<br>**d.** Formulation of Hypothesis<br>**e.** Formulation of research Design<br>**f.** Sample Design<br>**g.** Data Collection<br>**h.** Data Analysis<br>**i.** Hypothesis testing and Interpretation of Data<br>**j.** Preparation of Research Report | 08 |
| 5 | **Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 04 |
| 6 | **Outcome of Research:** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation | 04 |

**Books Recommended:**

**Reference Books:**


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


**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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2027 | IPR and Patenting (abbreviated as IPRP) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2027 | IPR and Patenting | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand intellectual property rights protection system<br>• To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures<br>• To get acquaintance with Patent search and patent filing procedure and<br>• applications |
| **Course Outcomes** | Student will be able to…<br>1. understand Intellectual Property assets<br>2. assist individuals and organizations in capacity building<br>3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.<br>**Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development | 05 |
| 2 | **Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement<br>**Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | 07 |

| | | |
|---|---|---|
| 3 | **Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc. | 06 |
| 4 | **Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent | 07 |
| 5 | **Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.) | 08 |
| 6 | **Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement<br>**Patent databases:** Important websites, Searching international databases | 07 |

**Books Recommended:**

**Reference Books:**


1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield,2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 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 andmohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 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, PritiMathur, AnshulRathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency

**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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2028 | Digital Business Management (abbreviated as DBM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2028 | Digital Business Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize with digital business concept<br>• To acquaint with E-commerce<br>• To give insights into E-business and its strategies |
| **Course Outcomes** | Student will be able to …..<br>1. Identify drivers of digital business<br>2. Illustrate various approaches and techniques for E-business and management<br>3. Prepare E-business plan |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Digital Business:** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business, | 09 |

| | | |
|---|---|---|
| 2 | **Overview of E-Commerce: E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | 06 |
| 3 | **Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, **Application Development:** Building Digital business Applications and Infrastructure | 06 |
| 4 | **Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e- business -Security Overview, Electronic Commerce Threats, Encryption, ryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key | 06 |
| 5 | **E-Business Strategy**-E-business Strategic formulation- Analysis of Company‘s Internal and external environment, Selection of strategy,<br>E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | 04 |
| 6 | **M Materializing e-business: From Idea to Realization**-Business plan preparation<br>**Case Studies and presentations** | 08 |

**Books Recommended:**

**Reference Books:**


1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan

8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

**Assessment:**

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.

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ILO2029 | Environmental Management (abbreviated as EVM) | 3 | - | - | 3 | - | - | 3 |

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ILO2029 | Environmental Management | 20 | 20 | 20 | 80 | - | - | - | 100 |

| | |
|---|---|
| **Course Objectives** | • Understand and identify environmental issues relevant to India and global concerns<br>• Learn concepts of ecology<br>• Familiarise environment related legislations |
| **Course Outcomes** | Student will be able to…<br>1. Understand the concept of environmental management<br>2. Understand ecosystem and interdependence, food chain etc.<br>3. Understand and interpret environment related legislations |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities.<br>Environmental issues relevant to India, Sustainable Development, the Energy scenario. | 10 |
| 2 | Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc. | 06 |
| 3 | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | 05 |

| | | |
|---|---|---|
| 4 | Scope of Environment Management, Role & functions of Government as a planning and regulating agency.<br>Environment Quality Management and Corporate Environmental Responsibility | 10 |
| 5 | Total Quality Environmental Management, ISO-14000, EMS certification. | 05 |
| 6 | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc. | 03 |

**Books Recommended:**

**Reference Books:**


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


**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.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXL2021 | Laboratory-III Emerging Trends in SOC Design | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical And Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ELXL2021 | Laboratory-III Emerging Trends in SOC Design | - | - | - | - | - | 25 | 25 | 50 |

**Term Work:**

At least 10 experiments covering the entire syllabus of ELXC2022 (**Emerging Trends in SOC 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. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exams will be based on the entire syllabus.

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

1. **Develop** commercial tools for SoCs
2. **Demonstrate** how to program a processor on a Fixed Virtual Platform using a mixture of Verilog, Assembly language and C code.
3. **Configure** and implement peripherals to control General Purpose Input and Output Ports (GPIOs).
4. **Understand** the operation of GPIO, memory access and controllers, and various memory types in a typical SoC.
5. **Understand** the properties of a System on Chip, and its design flow
6. **Configure** and implement SoC for different applications.

**Note:** The action verbs according to Bloom's taxonomy are highlighted in bold.

**Suggested List of Experiments**

| Sr. No. | Experiment Title |
|---|---|
| | **Digital(Any 8)** |
| 1 | Implement Rising Edge D Flip Flop on FPGA |
| 2 | Implement full adder on FPGA |
| 3 | Implement 2-bit comparator on FPGA |
| 4 | Implement up-counter with test-bench on FPGA |
| 5 | Implement Arithmetic Logic Unit (ALU) on FPGA |
| 6 | Implement debouncing buttons on FPGA |
| 7 | Implement Decoders on FPGA |
| 8 | Implement Multiplexers on FPGA |
| 9 | Implement Clock divider on FPGA |
| 10 | Implement PWM generator on FPGA |
| 11 | Implement single-port RAM on FPGA |
| 12 | Implement 16-bit single-cycle MIPS processor on FPGA |
| 13 | Implement reading image files into FPGA |
| 14 | Non-linear Lookup Table Implementation on FPGA |
| 15 | Implement Moore FSM Sequence Detector on FPGA |
| 16 | Implement Reference designs for SoCs, MCUs, ASICs, and FPGAs using Xilinx®, Intel®, and Texas Instruments™ design tools. |

| | **Analog(Any Two)** |
|---|---|
| 1 | Designing and testing a sinewave table in ROM using SPI |
| 2 | A fixed /variable frequency sinewave generator using SPI |
| 3 | D-to-A conversion using pulse-width modulation using SPI |

**Note:** Experiments can be performed online using simulation software as well as hardware. Simulation software Xilinx can be used to perform the experiments.

***(Expected percentage of H/w and software experiments should be 20% & 80% respectively)***

***Note:***
***Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.***

| Course Code | Course Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ELXL2022 | LAB-1V Advanced Digital Signal Processing LAB | - | 2 | - | - | 1 | - | 1 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | | | |
| | | Internal assessment | | | End Sem. Exam | Term Work | Practical | Oral | Total |
| | | Test 1 | Test 2 | Avg. Of Test 1 & Test 2 | | | | | |
| ELXL2022 | LAB-1V Advanced Digital signal Processing LAB | - | - | - | - | 25 | - | 25 | 50 |

**Course Pre-Requisites:**

1. Basic knowledge of Signals and Systems, DSP.
2. Acquaintance of Simulation languages and software tools.

**Course Objectives:**

1. To design and simulate basic DSP systems and multirate systems for practical applications.
2. To design and simulate DSP systems for spectral analysis of signals and optimum filters for different applications
3. To design and simulate adaptive filters for real world applications

**Course Outcomes:**
Students will be able to

1. Implement basic DSP algorithms and multirate techniques for various situations.
2. Implement optimum filters for real world applications and extract spectral information.
3. Design and test adaptive filter systems for practical applications.

**List of Experiments:**

1. Basic filtering operations, like noise reduction using FIR filter, enhancement of ECG signal using notch filtering etc.
2. IIR filter .Simulation of Digital audio equalizer.
3. Biomedical signal processing, ECG signal processing.
4. Algorithms in DTMF tone generation.
5. Oversampling and Analog to digital conversion resolution.
6. Sampling rate reduction by an integer factor, sampling rate increase by an integer factor.
7. Changing Sampling rate by a non integer factor L/M.
8. Upsampling and Interpolation filter processes in CD audio systems.
9. Noise cancellation using adaptive filters.
10. System modeling using adaptive filters.

11. Line enhancement using linear prediction.
12. Subband decomposition and two channel perfect reconstructions QMF bank.

Students are required to perform any **six experiments** from the above list covering most of the topics in Advanced Signal processing and perform **one mini project** preferably based on any of the above topics 2,4,8,or 12.

**Reference Books:**


1. Digital Signal Processing Fundamentals & Applications.2/e Li Tan & Jean Jiang Elsevier, Academic press.
2. Digital Signal Processing. A computer based approach, S.K.Mitra, Tata Mc Graw Hill.

## SEMESTER–III

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

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

## SEMESTER–IV

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

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | Term Work | Practical | Oral | Total |
| | | Internal Assessment | | | End Sem Exam | | | | |
| | | Test1 | Test2 | Average | | | | | |
| ELXD4041 | Dissertation-II | --- | --- | --- | --- | 100 | --- | 100 | 200 |
| TOTAL | | | | | | 100 | | 100 | 200 |

**Note:**

- In case of Seminar (ELXS3031), 01 Hour / week / student should be considered for the calculation of load of a teacher

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

## SEMESTER III

| Course Code | Course Name | Credits |
|---|---|---|
| ELXS3031 | Seminar | 03 |

**Guidelines for Seminar**

- Seminar should be based on thrust areas in Electronics and Telecommunication Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the topic and compile the report in standard format and present infront of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.

Seminar should be assessed based on following points

- Quality of Literature survey and Novelty in the topic
- Relevance to the specialization
- Understanding of the topic
- Quality of Written and Oral Presentation

**IMPORTANT NOTE:**

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.
2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.
3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

## SEMESTER III/IV

| Course Code | Course Name | Credits |
|---|---|---|
| ELXD3031/ ELXD4041 | Dissertation I/ Dissertation-II | 12+15 |

**Guidelines for Dissertation**

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

**Guidelines for Assessment of Dissertation I**

- Dissertation I should be assessed based on following points
- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

**Guidelines for Assessment of Dissertation II**

- Dissertation II should be assessed based on following points
- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted
- Validation of results
- Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai
- Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)