UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV-2019'C' Scheme) from Academic Year 2019–20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	Final Year of B.E in Electronics Engineering
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**4 Years / 8 Semesters**
6	Level	P.G. / **U.G.**/ Diploma / Certificate (Strike out which
7	Pattern	Yearly / **Semester** (Strike out which is not applicable)
8	Status	New / Revised **REV- 2019 'C'**
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Date:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Technology University of Mumbai

Dr. Anuradha Majumdar
Dean
Faculty of Science and
University of Mumbai

Preamble

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

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 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 Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

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

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

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

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

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 toto. 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 curriculum for Electronics Engineering program to be implemented from academic year 2020-21. 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) i.e. lifelong learning.

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 Third Year Electronics Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ELC701	Power Electronics	3	--	3	--	3
ELC702	Internet of Things	3	--	3		3
ELDO701	Department Optional Course – 3	3	--	3	--	3
ELDO702	Department Optional Course – 4	3	--	3	--	3
ELIO701	Institute Optional Course - 1	3	--	3	--	3
ELL701	Power Electronics Lab	--	2	--	1	1
ELL702	Internet of Things Lab	--	2	--	1	1
ELL703	Department Optional Course III Lab	--	2	--	1	1
ELP701	Major Project I	--	$6^{\#}$	--	3	3
	Total	**15**	**12**	**15**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)	Term Work	Prac/ Oral	Total
		Test 1	Test 2	Avg					
ELC701	Power Electronics	20	20	20	80	3	--	--	100
ELC702	Internet of Things	20	20	20	80	3	--	--	100
ELDO701	Department Optional Course – 3	20	20	20	80	3	--	--	100
ELDO702	Department Optional Course – 4	20	20	20	80	3	--	--	100
ELIO701	Institute Optional Course - 1	20	20	20	80	3	--	--	100
ELL701	Power Electronics Lab	--	--	--	--	--	25	25	50
ELL702	Internet of Things Lab	--	--	--	--	--	25	25	50
ELL703	Department Optional Course III Lab	--	--	--	--	--	25	25	50
ELP701	Major Project I	--	--	--	--	--	50	--	50
Total		--	--	100	400	--	125	75	700

Department Optional Courses:

Department Optional Course III (ELDO701)	Department Optional Course IV (ELDO702)
1. Mixed Signal VLSI Design	1. Wireless Communication
2. Embedded GPU	2. Cloud Computing
3. Artificial Intelligence	3. Robotics
4. Advanced Networking Technologies	4. Data Science and applications

Institute Optional Course – 1 (Semester- VII)

ILO7011	Product Lifecycle Management	ILO7016	Cyber Security and Laws
ILO7012	Reliability Engineering	ILO7017	Disaster Management and Mitigation Measures
ILO7013	Management Information System	ILO7018	Energy Audit and Management
ILO7014	Design of Experiments	ILO7019	Development Engineering
ILO7015	Operation Research		

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC701	Power Electronics	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					
ELC701	Power Electronics	20	20	20	80	03	-	-	100

Course Prerequisites:

1. Electronic Devices and Circuits (ELC302)
2. Electrical Network Analysis (ELC304)

Course Objectives:

1. To develop the understanding of fundamental principles of power electronics.
2. To disseminate various power electronic semiconductor devices and their characteristics.
3. To develop the concept of power electronic converters and their topologies.

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

1. **Describe** the features and characteristics of power semiconductor devices.
2. **Analyze** and **design** triggering, commutation and protection circuits.
3. **Illustrate, analyze** and **design** AC-DC converters.
4. **Illustrate, analyze** and **design** DC-DC converters.
5. **Illustrate, analyze** and **design**DC-AC converters.
6. **Illustrate, analyze** and **design** AC-AC converters.

Module No.	Unit No.	Contents	Hrs.
1		**Power Semiconductor Devices**	04
	1.1	Principle of operation, constructional features and characteristics of: SCR, TRIAC, DIAC, GTO, MOSFET and IGBT.	
2		**Triggering, Commutation and Protection**	06
	2.1	Basic Gate Drive circuits for SCR, TRIAC, MOSFET and IGBT.	
	2.2	Methods of commutation of SCR.	
	2.3	Methods of protection of SCR.	
3		**AC-DC Converters**	06
	3.1	Uncontrolled half and full wave rectifiers with R and RL load.	
	3.2	SCR controlled half and full wave rectifier with R and RL load. Power factor of the controlled rectifier. Effect of source and load inductances.	
4		**DC-DC Converters**	08
	4.1	Buck, Boost and Buck-Boost converters.	
	4.2	Flyback and Cúk converter	
	4.3	DC-DC converters with R and RL load.	
5		**DC-AC Converters**	08
	5.1	Principle of operation and performance parameters.	
	5.2	Voltage control of single phase inverters	
6		**AC-AC Converters**	07
	6.1	Principle of on-off and phase angle control; performance parameters.	
	6.2	Single phase full-wave AC-AC converter with R and RL load.	
		Total	39

Text Books:

1. N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.
2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.
3. P.S. Bhimbra, Power Electronics, Khanna Publishers, 2012.
4. M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw Hill
5. Power Electronics Systems: Theory and Design, J. P. Agrawal,Pearson Education

Reference Books:

1. P.C. Sen, Modern Power Electronics, Wheeler publications.
2. Ramamurthy, Thyristor & Their Applications
3. S. Shrivastava, Power Electronics, Nandu publications, Mumbai.

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
ELC 702	Internet of Things	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					
ELC 702	Internet of Things	20	20	20	80	03	-	-	100

Course Pre-requisite:

Computer Networks, Embedded Systems, Web Technologies

Course Objectives:

1. To understand the basic building blocks of IoT
2. To understand various IoT protocols.
3. To introduce data handling in IoT
4. To understand the Design Methodology in IoT through case studies.

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

1. Understand concepts, functional blocks and communication methodology relevant to IoT.
2. Identify various components of IoT
3. Compare various communication protocols for IoT.
4. Understand various methods for data handling in IoT-based systems.
5. Design basic applications based on IoT using specific components.
6. Introduce various security issues in IoT

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to IoT**	5
	1.1	Definition and Characteristics of IoT	
	1.2	IoT Protocols	
	1.3	IoT Functional Blocks	
	1.4	IoT Communication Models	
	1.5	IoT Communication APIs :- REST and WebSockets	
	1.6	IoT Enabling Technologies	
	1.7	Introduction to M2M and Difference between IoT and M2M	
2		**Components (Things) in IoT**	5
	2.1	Sensor Technology, Examples of Sensors	
	2.2	Actuators	
	2.3	Applications of RFID and WSN in IoT	
	2.4	Exemplary Device:- R–Pi and its Interfaces, PCDuino, BeagleBone	
3		**Data Handling in IoT**	
	3.1	Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics	9
	3.2	Data Collection, Storage and Computing Using Cloud Platform,	
	3.3	Introduction to Cloud Computing, Virtualization, Cloud Models, Cloud Services	
	3.4	IoT Cloud-based Data Collection, Storage, Computing using Xively	
4		**Design Principles for Web Connectivity**	10
	4.1	Communication Technologies – A comparison	
	4.2	Web Communication Protocols for connected devices:- CoRE Environment, CoAP, LWM2M, MQTT, XMPP, HTTP, SOAP Protocols	
	4.3	LPWAN Fundamentals: LORA and NBIoT	
5		**IoT Design Methodology**	6
	5.1	Defining Specifications About**:-** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration:- Case Studies of Home automation, Weather Monitoring	
	5.2	IoT Levels and Deployment Templates	
	5.3	Supply Chain Management	
6		**IoT Security and Vulnerabilities Solutions**	4
	6.1	Iot Security Tomography and Layered Attacker Model	3
	6.2	Identity Management, Establishment, Access Control and Secure Message Communication	
	6.3	Security Protocols	
		Total	**39**

Text Books:

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

Reference Books:

1. Adrian McEwen, Hakim Cassimally: Designing the Internet of Things", Paperback, First Edition.
2. Yashvant Kanetkar, Shrirang Korde : Paperback "21 Internet of Things (IOT) Experiments" , BPB 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 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
ELDO701	Mixed Signal VLSI 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					
ELDO701	Mixed Signal VLSI Design	20	20	20	80	03	-	-	100

Course Pre-requisite:

ELC302 -Electronics Devices and Circuits - I
ELC303 -Digital Logic Circuits
ELC304 -Electrical Networks Analysis and Synthesis
ELC402 -Electronics Devices and Circuits – II
ELC503 -Linear Integrated Circuits
ELC601 -Basic VLSI Design

Course Objectives:

1. To know importance of Mixed Signal VLSI design in the field of Electronics.
2. To understand various methodologies for analysis and design of fundamental CMOS analog and mixed signal Circuits.
3. To learn various issues associated with high performance Mixed Signal VLSI Circuits
4. To design, implement and verify various mixed signal VLSI circuits using open source tools like Ngspice and Magic

Course Outcomes:

1. After successful completion of the course student will be able to:
2. Know operation of the various building blocks of analog and mixed signal VLSI circuits.
3. Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits.

4. Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit.
5. Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
6. Evaluate and select appropriate circuit/configuration for given application.
7. Design analog and mixed signal VLSI circuits for given application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Integrated Circuit Biasing Techniques**	**06**
	1.1	Active resistance, current source, current sink, simple current mirror, cascode current mirror	03
	1.2	Current and voltage references, Band gap reference generator	03
2.0		**Single Stage MOS Amplifiers**	**08**
	2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, simulation of CMOS amplifiers using SPICE	04
	2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	04
3.0		**Noise in MOS Circuits**	**06**
	3.1	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise	02
	3.2	Representation of noise in circuits, noise in single stage CS, CD and CG amplifier	02
	3.3	Noise in differential pairs, noise bandwidth	02
4.0		**CMOS Operational Amplifier**	**06**
	4.1	Design of Current Mirror Load Differential Amplifier,	02
	4.2	Design of two stage Operational Transconductance Amplifier, OpAmp Compensation Techniques, Basic CMOS comparator Design	04
5.0		**Data Converter Fundamentals**	**05**
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals,	03
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues	02
6.0		**Data Converter Architectures**	**08**

	6.1	DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC	04
	6.2	ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC	04
		Total	**39**

Text Books:

1. B. Razavi, "Design of Analog CMOS Integrated Circuits", first edition, McGraw Hill, 2001.
2. P.E.Allen and D R Holberg, "CMOS Analog Circuit Design", second edition, Oxford University Press, 2002.
3. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley, 2nd Edition, 2013

Reference Books:

1. Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, "Microelectronics Circuits Theory and Applications", Fifth Edition, Oxford University Press.
2. Gray, Meyer, Lewis and Hurst "Analysis and design of Analog Integrated Circuits", 4th Edition Willey International, 2002
3. Tony Chan Carusone, David Johns, Kenneth Martin, " Analog Circuit Design", Second Edition, Wiely

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO701	Embedded GPU	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					
ELDO701	Embedded GPU	20	20	20	80	03	-	-	100

Course Objectives:

1. To understand the basics of GPU architectures and optimization for embedded GPUs.
2. To write programs for massively parallel processors.
3. To understand the issues in mapping algorithms for GPUs.
4. To introduce different GPU programming models.

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

1. **Understand** the GPU computing architecture.
2. **Code** with GPU programming environments.
3. **Design** and **develop** programs using GPU processing power.
4. **Develop** solutions to solve computationally intensive problems in various fields.

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

Module No.	Unit No.	Contents	Hrs.
1		**INTRODUCTION TO EMBEDDED GPU**	**06**
	1.1	Review of Traditional Computer Architecture – Basic five stage RISC Pipeline, Cache Memory, Register File, SIMD instructions, Evolution, GPU Computing. Embedded v/s discrete GPUs, Performance v/s Power tradeoff in embedded GPUs	
	1.2	Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling	
	1.3	Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory, Unified memory in embedded GPUs.	
	1.4	Optimizations in embedded GPUs: Unified memory, reduced peripherals, cost reductions, performance, higher operating temperature range, longer support timelines	
2		**GPU PROGRAMMING & EXECUTION MODELS**	**07**
	2.1	Execution model of GPU- memory allocation and data transfer to DRAM by CPU, kernel launch, execution by threads.	
	2.2	Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions, Self-tuning Applications.	
3		**PROGRAMMING ISSUES**	**06**
	3.1	Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.	
	3.2	Profiling and optimizing	
4		**ALGORITHMS ON GPU**	**08**
	4.1	Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix - Matrix Multiplication - Programming Heterogeneous Cluster - CUDA Dynamic Parallelism.	
	4.2	Example Deep Neural Network which uses above algorithms	
5		**HETEROGENEOUS COMPUTING**	**07**
	5.1	Introduction to OpenCL – OpenCL Device Architectures – Basic OpenCL – examples – Understanding OpenCL – Concurrency and Execution Model – Dissecting a CPU/GPU – OpenCL Implementation – OpenCL, OpenCL for Heterogeneous Computing	
	5.2	Application design using OpenCL	
6		**GPU DEVICES AND APPLICATIONS**	**05**
	6.1	Introduction to Jetson Nano by NVIDIA	
	6.2	Application design on Jetson Nano	
		Total	**39**

Text Books:

1. "Computer Architecture -- A Quantitative Approach" - John L.Hennessy and David A. Patterson, Fifth Edition, Morgan Kaufmann.
2. Heterogeneous Computing with OpenCL" -- Benedict Gaster,Lee Howes, David R. Kaeli, Elsevier, 2013
3. Aaftab Munshi, Benedict Gaster, Timothy G. Mattson, James Fung & Dan Ginsburg, "OpenCL Programming Guide", Addison-Wesley Professional, 2011.
4. Jeston_TK1_User_Guide.pdf, NVIDIA

Reference Books:

1. Programming Massively Parallel Processors-A hands-on-Approach, David Kirk, Wen-mei W. Hwu.
2. Fundamentals of Parallel Multicore Architecture, Chapman and Hall/CRC Computational Science.
3. Modern Processor Design: Fundamentals of Superscalar Processors, Shen, John Paul, Lipasti, Mikko H.
4. General-Purpose Graphics Processor Architecture – Tor M. Aamodt, Wilson Wai Lun Fung, Timothy G. Rogers, Morgan and Claypool Publishers.
5. https://coreavi.com/wp-content/uploads/CoreAVI-White-Paper-Weighing-the-Factors-of-Discrete-Versus-Embedded-GPUs.pdf.

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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDLO701	Artificial Intelligence	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					
ELDLO701	Artificial Intelligence	20	20	20	80	03	-	-	100

Course Objectives:

1. To gain perspective of AI and its foundations.
2. To study different agent architectures and properties of the environment.
3. To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning.
4. To investigate probabilistic reasoning under uncertain and incomplete information.
5. To explore the current scope, potential, limitations, and implications of intelligent systems.

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

1. **Identify** the characteristics of the environment and differentiate between various agent architectures.
2. **Apply** the most suitable search strategy to design problem solving agents.
3. **Represent** a natural language description of statements in logic and **apply** the inference rules to design Knowledge Based agents.
4. **Apply** a probabilistic model for reasoning under uncertainty.
5. **Comprehend** various learning techniques.
6. **Describe** the various building blocks of an expert system for a given real word problem.

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

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Artificial Intelligence**	**5**
	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	
	1.2	History of AI, Applications of AI, The present state of AI, Ethics in AI	
2		**Intelligent Agents**	**6**
	2.1	Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents	
	2.2	Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agents.	
	2.3	Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent	
3		**Solving Problems by Searching**	**8**
	3.1	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	
	3.2	Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality	
	3.3	Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	
	3.4	Informed Search: Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search, Optimization: Genetic Algorithm	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning	
4		**Knowledge and Reasoning**	**8**
	4.1	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	
	4.2	Propositional Logic (PL): Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula,	
	4.3	Predicate Logic: FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL, Introduction to logic programming (PROLOG)	
	4.4	Forward Chaining, Backward Chaining and Resolution in	

		FOPL	
5	**5.1**	**Reasoning Under Uncertainty**	**5**
		Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	
	5.2	Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	
6		**Planning and Learning**	
	6.1	The planning problem, Partial order planning, total order planning.	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.	**7**
	6.3	Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	
		Total	**39**

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence - A Modern Approach-Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight "Artificial Intelligence", Third Edition", Tata McGraw-Hill Education Pvt. Ltd., 2008.
3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition

Reference Books:

1. Ivan Bratko, "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3. Saroj Kaushik "Artificial Intelligence", Cengage Learning.
4. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
6. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

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

End Semester Examination:
1. Question paper will 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO701	Advanced Networking Technologies	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					
ELDO701	Advanced Networking Technologies	20	20	20	80	3	--	--	100

Course Objectives:

1. To understand the characteristic features of Various Wireless networks.
2. To understand the characteristic features of Optical networks.
3. To introduce the need for network security and safeguards.

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

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode (ATM).
3. Analyze the importance of Optical networking
4. Demonstrate knowledge of network design and security and management.
5. Understand the concept of multimedia networks

Module No.	Unit No.	Contents	Hrs.
1		**Wireless LAN and WAN Technologies**	08
	1.1	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks	
	1.2	IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA, Physical Layer, 802.11 Security considerations	
	1.3	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM cells , ATM Functional Layers, Congestion control and Quality of service	
2		**Optical Networking**	06
	2.1	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	2.2	DWDM: Frame format, DWDM architecture, Optical Amplifier, Optical cross connect Performance and design considerations.	
3		**Routing in the Internet**	08
	3.1	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	3.2	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
4		**Network Security**	08
	4.1	Security goal, Security threats, security safeguards, firewall types and design, IPTABLES	
	4.2	Internet Security: Network Layer Security, Transport Layer Security, Application Layer Security	
5		**Multimedia Information and Networking**	06
	5.1	Compression Fundamentals, Digital Representation, Compression techniques,	
	5.2	Multimedia Communication across networks, RTP, RTSP, SIP, H.323	
		Network Design	03
	6.1	3 tier Network design layers: Application layer, Access layer	
6	6.2	Backbone layers, Ubiquitous computing and Hierarchical computing	
		Total	39

Text Books:

1. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
2. J F. Kurose & KW. Ross: Computer Networking- A Top-down Approach featuring the Internet, 3rd edition,
3. Darren L. Spohn , "Data Network Design" , McGraw Hill Education ,Third edition
4. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition

Reference Books:

1. K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India.
2. Deven Shah , Ambavade, "Advanced Communication Networking"
3. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education, 4th edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO702	Wireless 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 of Test 1 and Test 2					
ELDO702	Wireless Communication	20	20	20	80	03	-	-	100

Course Pre-requisite:

1. Principles of Communication Engineering (ELC404).
2. Digital Communication (ELC504).
3. Computer Communication Networks (ELC603).

Course Objectives:

1. To introduce the concepts of basic Cellular communication systems.
2. Learn to model radio signal propagation issues and its impact on mobile communication system's performance.
3. An ability to explain multiple access techniques for wireless communication.
4. To compare recent technologies used for wireless communication.
5. To comprehend the features of GSM cellular concept and analyse its services and features.
6. Explore higher generation cellular standards and upcoming technologies 4G and 5G.

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

1. Understand the key concepts of basic cellular system and the **design** requirements.
2. **Derive** the various mobile radio propagation models.
3. **Analyze** various multiple access techniques for wireless communication.
4. **Evaluate** the performance of recent wireless technologies.
5. Acquire the knowledge about GSM cellular concept and **analyse** its services and features.
6. **Analyse** different technologies used for wireless communication systems and standards.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to the Cellular Communication**	**06**
	1.1	Concept of cellular communication: Hexagonal geometry cell and Concept of frequency reuse, Channel assignment strategies.	
	1.2	Cellular Processes: Call setup, Handoff strategies, Channel & Co-channel interference and system capacity, Co-channel Interference reduction with the use of Directional antenna.	
	1.3	Traffic Theory: Trunking and Grade of service, Improving coverage and capacity in Cellular systems: Cell splitting, Sectoring, Micro-cell Zone concept.	
2		**Mobile Radio Propagation**	**08**
	2.1	Introduction to Radio wave propagation: Free space propagation model, the three basic Propagation mechanisms Reflection, Diffraction, Scattering. Indoor and Outdoor propagation Models.	
	2.2	Small scale Multipath Propagation: Factors influencing small scale fading, Doppler shift, Parameters of mobile multipath channels.	
	2.3	Types of small scale fading, Fading effects due to Doppler spread and Multipath Time delay spread, Raleigh and Rician distributions	
3		**Spread spectrum Modulation and Multiple Access Techniques**	**06**
	3.1	Spread Spectrum (SS) Modulation: Need for and concept of spread spectrum modulation, Direct sequence Spread Spectrum (DSSS), Frequency-hopping SS(FHSS).	
	3.2	Multiple Access Techniques: Introduction, Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Code Division Multiple Access(CDMA), Orthogonal Frequency Division Multiple Access (OFDMA) based on spectral efficiency, advantages, disadvantages and applications	
4		**Recent Wireless Technologies**	**05**
	4.1	Multicarrier modulation: OFDM, MIMO system, Diversity multiplexing trade-off, MIMO-OFDM system.	
	4.2	Smart-antenna: Beam forming and Multiple Input Multiple output (MIMO), Cognitive radio, Software defined radio, Spectrum sharing.	
5		**GSM**	**06**
	5.1	Global System for Mobile Communications (GSM) network architecture, Signalling protocol architecture, Identifiers, Physical and Logical Channels, Authentication and security, Call procedure, Hand-off procedure, Services and features.	
	5.2	Overview of IS-95 to CDMA2000 cellular technology, General Packet Radio Services (GPRS) system architecture.	
6		**Higher Generation Cellular Systems**	**08**
	6.1	3G Standard: W-CDMA (UMTS) evolved Enhanced Data rates for GSM Evolution (EDGE), 3G Network architecture, Limitation of 3G and motivation for 4G.	
	6.2	4G Standard: Evolution in Network architecture from 3G to 4G, LTE, LTE Radio Access, Physical transmission resources, Downlink and Uplink physical-layer processing, Scheduling and Rate adaptation.	

	6.3	5G Standard: 5G Architecture, Planning of 5G Network, Quality of Service, Radio Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization.	
		Total	**39**

Text Books:

1. T. S. Rappaport, "Wireless Communications, Principles and Practice", 2nd edition, Prentice Hall, 2010.
2. T. L. Singal , "Wireless Communication", 1st edition Tata McGraw Hill , 2010.
3. Iti Saha Misra, "Wireless Communication and Networks: 3G and Beyond", 2nd edition, Tata McGraw Hill.
4. William C. Y. Lee, "Wireless and Cellular Communications", 3rd edition, Tata McGraw Hill, 2006.
5. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless systems", Springer, 2007.

Reference Books:

1. Jochen Schiller, "Mobile Communications", PHI/Pearson Education, 2nd edition, 2003.
2. Vijay K Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian Reprint).
3. William Stallings, "Wireless Communications & Networks", 2nd edition, Prentice Hall, 2004.
4. Wei Xiang & Kan Zheng, "5G Mobile Communications", 1st Springer, 2017.
5. Saad Asif, "5G Mobile Communications Concepts and Technologies", 1st CRC Press, 2018.

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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO702	Cloud Computing	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					
ELDO702	Cloud Computing	20	20	20	80	3	--	--	100

Course Pre-requisite:

Computer networks, Basics of operating system (O.S.)

Course Objectives:

1. To provide an overview of cloud computing fundamentals.
2. To make students familiar with the key concepts of virtualization.
3. To explore various cloud computing services.
4. To create an open source cloud.
5. To identify risks and provide cloud security.
6. To analyze several cloud applications and recent trends in cloud computing.

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

1. Define cloud computing and understand different cloud services and deployment models.
2. Implement different types of virtualization.
3. Use several cloud computing services.
4. Design ofopen source cloud.
5. Identification of threats and cloud-based risks for cloud security.
6. Understand cloud applications and recent trends.

Module No.	Unit No.	Contents	Hrs.
0		**Pre-requisites:** Basics of operating system (O.S.), ISO-OSI model and its layers	2
1		**Introduction to Cloud Computing**	4
	1.1	Definition of cloud computing and cloud data centre, NIST model and cloud cube model, and characteristics of cloud computing.	
	1.2	Cloud deployment models (private, public, hybrid, and community) and service models (SaaS, PaaS, and IaaS).	
	1.3	Impact of cloud computing on business, key drivers for cloud computing.	
	1.4	Advantages and disadvantages of cloud computing.	
		Self-learning topics: Comparison between cloud service providers with traditional IT service providers.	
2		**Virtualization**	8
	2.1	Introduction and benefits of virtualization, implementation levels of virtualization, VMM.	
	2.2	Virtualization at O.S. level, middleware support for virtualization, virtualization structure/tools and mechanisms, hypervisor and xen architecture, binary translation with full virtualization, para virtualization with compiler support.	
	2.3	CPU virtualization, memory virtualization and I/O virtualization, virtualization in multicore processors, demonstration of virtualization using type II hypervisor.	
		Self-learning topics: Comparison between virtualization and containerization (docker).	
3		**Cloud Computing Services**	5
	3.1	Exploring different cloud computing services: Software-as-a-Service (SaaS) (e.g., Dropbox, Google Workspace, Salesforce, etc.), Platform-as-a-Service (PaaS) (e.g., AWS Elastic Beanstalk, Windows Azure, Heroku, Google App Engine, etc.), Infrastructure-as-a-Service (IaaS) (e.g., Digital Ocean, AWS, Microsoft Azure, Google Compute Engine (GCE), etc.).	
	3.2	Anything-as-a-Service or Everything-as-a-Service (XaaS), Security-as-a-Service, Identity Management-as-a-Service, and Database-as-a-	

		Service.	
	3.3	Storage-as-a-Service, Collaboration-as-a-Service, Compliance-as-a-Service, Monitoring-as-a-Service, Communication-as-a-Service, Network-as-a-Service Disaster Recovery-as-a-Service, Analytics-as-a-Service, and Backup-as-a-Service	
		Self-learning topics: Explore any 10 services offered by AWS/Microsoft Azure.	
4		**Open Source Cloud Implementation of Open Stack and Eucalyptus**	
	4.1	Open Stack Cloud Architecture, Features of Open Stack, Components of Open Stack, Mode of Operations of Open Stack	
	4.2	Eucalyptus Architecture, Features of Eucalyptus, Components of Eucalyptus, Mode of Operations of Eucalyptus	7
	4.3	Installation and configuration process of Open Stack and Eucalyptus	
		Self-learning topics: Explore open source cloud and edge computing platform for an enterprise: Open Nebula.	
5		**Cloud Security**	
	5.1	Security overview, cloud security challenges and risks, SaaS security, cloud computing security architecture, architectural considerations.	
	5.2	General issues in securing cloud, securing data, application, and virtual machine security.	7
	5.3	AAA model, automatic security establishing trusted cloud computing, secure execution environments and communications, access control, disaster recovery in clouds.	
		Self-learning topics: Cloud security in AWS/Microsoft Azure/Google Cloud Platform.	
6		**Cloud Applications and Recent Trends**	
	6.1	**Cloud Applications:**	6
		Scientific Applications:	
		Healthcare: ECG analysis in cloud	
		IoT-enabled Cloud Applications: Smart Agriculture	
		Business and Consumer Applications:	
		CRM and ERP, Productivity, networking, media applications,	

		multiplayer online gaming.	
	6.2	**Recent Trends:**	
		Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing.	
		Self-learning topics: Jungle computing, Fog computing, Quantum computing	
		Total	**39**

Text Books:

1. Mastering Cloud Computing by Raj Kumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education
2. Cloud Computing and Services by Arup Vithal, Bhushan Jadhav, StarEdu Solutions, SYBGEN Learning India Pvt. Ltd.
3. Cloud Computing: A Practical Approach for Learning and Implementation by A. Srinivasan, J. Suresh, Pearson.
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz, Russell DeanVines, Wiley & Sons.
5. Cloud Computing Bible by Barrie Sosinsky, Wiley Publishing.

Reference Books:

1. Cloud Computing Black Book by Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah, Dreamtech Press.
2. Amazon Web Services in Action by Michael Wittig, Andreas Wittig, Manning Publisher.
3. To the cloud: cloud powering an Enterprise, Arora Pankaj, Tata Mc Graw Hill Education.
4. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Morgan Kaufmann.

Useful Digital Links:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc22_cs20/preview
2. OpenStack Installation Guide: https://docs.openstack.org/install-guide/
3. Eucalyptus Installation: https://docs.eucalyptuscloud.org/eucalyptus/4.4.4/install-guide-4.4.4.pdf
4. AWS Management Console: https://aws.amazon.com/console/
5. https://ndl.iitkgp.ac.in NOC: Cloud Computing https://rb.gy/wyjtjx
6. https://ndl.iitkgp.ac.in NOC :Cloud Computing and Distributed Computing – Virtualization
7. https://rb.gy/uuyzq3

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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDLO702	Robotics	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					
ELDLO702	Robotics	20	20	20	80	3	--	--	100

Course Prerequisite:

Applied Mathematics III, Applied Mathematics IV, Linear Control Systems

Course Objectives:

1. To study basics of robotics
2. To familiarize students with the kinematics of robots.
3. To familiarize students with differential motion of robots
4. To familiarize students with Trajectory planning of robots.
5. To familiarize students with robot vision.
6. To familiarize students with Task planning of robots.

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

1. Understand the basic concepts of robotics
2. Perform the kinematic analysis of robots.
3. Perform the differential motion analysis of robots.
4. Perform trajectory and task planning of robots.
5. Describe the importance of sensors and visionary system in robotic manipulation.
6. Learn about application of Robots

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Robotics**	04
	1.1	Robot Classification, Robot Components, Robot Specification	
	1.2	Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications	
2		**Kinematics of Robots**	10
	2.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	
	2.2	Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and SCARA	
3		**Differential motions and velocities of robots**	06
	3.1	Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities	
4		**Trajectory planning and Path Planning**	08
	4.1	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	
	4.2	Bug 1 , Bug 2 and Tangent Bug Algorithm	
	4.3	A* search Algorithm, Simulated Annealing	
5		**Robot Vision and Sensors**	05
	5.1	Image representation, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform	
	5.2	Touch sensors, Tactile sensor, Proximity and range sensors, Force sensor, Light sensors, Pressure sensors.	
6		**Task Planning**	06
	6.1	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning	
	6.2	Simulation of Planar motion, Source and goal scenes, Task planner simulation	
		Total	39

Text Books:

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.
3. Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011

Reference Books:

1. S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, ChmiElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning, 2009.
3. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
4. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing Company Ltd., 1995.
5. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
6. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987
7. Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985
8. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006

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 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDLO702	Data Science and Applications	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					
ELDLO702	Data Science and Applications	20	20	20	80	3	--	--	100

Course Objectives:

1. To gain perspective of Big Data, Data Science and its Applications.
2. To learn basic concepts of statistics, probability.
3. To understand different stages in the Data Science Process.
4. To learn the basic data preprocessing, data cleaning and data transformation techniques.
5. To understand various algorithms and learning techniques used in data science.
6. To investigate the current scope, potential, limitations, and implications of data science and its applications across multiple domains.

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

1. **Translate** business challenge into data science challenge.
2. **Apply** structured lifecycle approach to data science projects.
3. **Analyze** the data, create statistical models, and identify insights that can lead to actionable results.
4. **Apply** various data analysis and visualization techniques.
5. **Apply various** algorithms and develop models for data science projects.
6. **To Provide** data science solutions for solving real business problems.

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

Module No.	Unit No.	Contents	Hrs
1		**Introduction**	
	1.1	Introduction to Data Science – Benefits and uses of data science, Facets of data, Data Science Process Overview, BI and Data Science, Tools and Skills required.	**6**
	1.2	The Big Data Ecosystem and Data Science - Big Data Characteristics, Distributed File System, Hadoop, Hadoop Core Components, Hadoop Ecosystem, Limitations of Hadoop.	
2		**Statistics and Probability**	
	2.1	Data types, Variable Types, Statistics, Sampling Techniques and Probability	
	2.2	,Information Gain and Entropy, Probability Theory, Probability Types, Probability distribution functions, Bayes Theorem, Inferential Statistics	**6**
3		**The Data Science Process**	
	3.1	Overview of Data Science Process, Step1- Defining Research Goals and creating project charter	
	3.2	Step2-Retrieving Data	
	3.3	Step3 -Cleaning, Integrating and Transforming data	
	3.4	Step4-Exploratory Data Analysis	
	3.5	Step5 -Build the Models	
	3.6	Step 6- Presenting findings and building the application	**6**
4		**Data Science and Machine Learning**	
	4.1	Applications of Machine Learning in data science	
	4.2	The Modeling Process	
	4.3	Machine Learning Algorithms: Linear Regression, Logistic Regression, Multinomial Logistic Regression, Decision Trees, Naive Bays, SVM, Clustering etc.	**8**
	4.4	Confusion Matrix, Case Study	
5		**Data Science and NoSQL Databases**	
	5.1	Introduction to NoSQL ACID the core principles of Relational databases, CAP Theorem, The BASE Principles of NoSQL databases,	**6**

	5.2	NoSQL Database Types- Key Value databases, Column family databases, Document databases, Graph Databases, Case Study	
6		**Data Science Applications and Tools**	
	6.1	Customer Segmentation, Recommendation systems	**7**
	6.2	Customer Sentiment Analysis, Fraud Detection, Stock Price Prediction etc	
	6.3	R, Python, Data Visualization using Tableau	
		Total	**39**

Text Books:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, "Introducing Data Science", Manning Publication.
2. Sanjeev Wagh, Manisha S. Bhende And Anuradha D. Thakare, "Fundamentals of Data Science", Thakare, Taylor and Francis Group, CRC Publication.
3. Dr. Vijayalakshmi and Dr. Radha Shankarmani "Big Data Analytics", Wiley Publication

Reference Books:

1. Davy Cielen, Meysman, Mohamed Ali, "Introducing Data Science", Dreamtech Press
2. Rachel Schutt and Cathy O'Neil, "Doing Data Science", O'Reilly Media
3. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
4. EMC Education Services, "Data Science and Big Data Analytics", Wiley

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
ILO7011	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.					
ILO7011	Product Lifecycle Management	20	20	20	80	-	-	-	100

Course Objectives	1. To familiarize the students with the need, benefits and components of PLM 2. To acquaint students with Product Data Management & PLM strategies 3. To give insights into new product development program and guidelines for designing and developing a product
Course Outcomes	Student will be able to… 1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Illustrate various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. 4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing 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 **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	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 (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
ILO7012	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.					
ILO7012	Reliability Engineering	20	20	20	80	-	-	-	100

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

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

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 (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
ILO7013	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.					
ILO7013	Management Information System	20	20	20	80	-	-	-	100

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

Module	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. 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. 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:

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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
ILO7014	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.					
ILO7014	Design of Experiments	20	20	20	80	-	-	-	100

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

Module	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			
ILO7015	Operation Research (abbreviated as OR)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		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.					
ILO7015	Operation Research	20	20	20	80	-	-	-	100

Course Objectives	- Formulate a real-world problem as a mathematical programming model. - Understand the mathematical tools that are needed to solve optimization problems. - Use mathematical software to solve the proposed models.
Course Outcomes	Student will be able to… 1. Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. 2. Understand the relationship between a linear program and its dual, including strong duality and complementary slackness. 3. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. 4. Solve specialized linear programming problems like the transportation and assignment problems. 5. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. 6. Understand the applications of, basic methods for, and challenges in integer programming 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. **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	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	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 (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
ILO7016	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.					
ILO7016	Cyber Security and Laws	20	20	20	80	-	-	-	100

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

Module	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** 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 (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
ILO7017	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.					
ILO7017	Disaster Management and Mitigation Measures	20	20	20	80	-	-	-	100

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

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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
ILO7018	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.					
ILO7018	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. - To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management - To relate the data collected during performance evaluation of systems for identification of energy saving opportunities
Course Outcomes	Student will be able to… - To identify and describe present state of energy security and its importance. - To identify and describe the basic principles and methodologies adopted in energy audit of an utility. - To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. - To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities - 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. 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. 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 (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
ILO7019	Development Engineering (abbreviated as DE)	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.					
ILO7019	Development Engineering	20	20	20	80	-	-	-	100

Course Objectives	• To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural • To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas • An exploration of human values, which go into making a _good' human being, a _good' professional, a _good' society and a _good life' in the context of work life and the personal life of modern Indian professionals • To understand the Nature and Type of Human Values relevant to Planning Institutions
Course Outcomes	Student will be able to… 1. Apply knowledge for Rural Development 2. Apply knowledge for Management Issues. 3. Apply knowledge for Initiatives and Strategies. 4. Develop acumen for higher education and research. 5. Master the art of working in group of different nature. 6. Develop confidence to take up rural project activities independently.

Module	Contents	Hours
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development. Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local. Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Books Recommended:

Reference Books:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

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			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL701	Power Electronics 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					
ELL701	Power Electronics Lab						25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL501 (**Power Electronics**) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Title
1	To study V-I characteristics of SCR, DIAC and TRIC
2	To study V-I characteristics of IGBT.
3.	To study different triggering circuits for SCR R Triggering circuit RC triggering circuit
4	To study class B commutation circuit of SCR.
5	To study Half wave controlled rectifiers using SCR.
6	To study AC phase control circuit using DIAC and TRIAC.
7	To study totem pole gate triggering circuit for MOSFET.
8	To study uncontrolled and controlled rectifiers.

9	To Study a controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.
10	To study buck and boost converters.
11	To study flyback converters.
12	To study single phase DC to AC converters.
13	To study AC to AC converters.

Note: All the experiments can be performed online using simulation software. 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, flexibilities lies with individual course instructor 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
ELL 702	Internet of Things 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					
ELL 702	Internet of Things Lab	-	-	-	-	-	25	25	50

Prerequisites: 1. Programming Using Arduino IDE
2. Python programming

Laboratory Outcomes:
After successful completion of the laboratory, students will be able to:

1. Interface various sensors to any IoT device and push data onto cloud.
2. Remotely control various devices using Blynk App and Node-red environment.
3. Implement IoT protocols to control devices remotely.
4. Implement services like Google Assistance, Adafruit I/O, IFTTT, Firebase etc in IoT.
5. Configure AWS Cloud and its Application in IoT

Term Work:

At least 10 experiments covering the entire syllabus of 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.

Suggested List of Experiments

Sr. No.	Experiment Title
1	Interfacing Various Sensors like LDR, ultrasonic, DHT etc (data collection) and pushing data on to Thingspeak Cloud
2	Controlling IoT devices/sensors remotely using Node-red and rpi.
3	Application of MQTT in node red
4	Control a LED Remotely & Monitor Temperature values with a Raspberry Pi using Node-RED
5	Controlling IoT devices using Blynk App.
6	Temperature and Humidity monitor using Blynk
7	ESP8266 Voice Control With Google Assistant and Adafruit IO and IFTTT.
8	Implementing Publish-Subscribe model using MQTT protocol and DHT11 sensor
9	Google Firebase :- controlling LED using Android App
10	Publishing sensor data from ESP32 to AWS IoT Cloud.
11	Device controlling over cloud on android mobile app :- Monitoring sensor and different data on mobile phone
12	Creating an Emergency push button to upload status on Facebook
13	To send Push notification to IoT device (R-pi to smart phone)
14	Google Assistant Controlled Switch Using NodeMCU
15	AWS and SNS service

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
ELL703	Mixed Signal 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					
ELL703	Mixed Signal VLSI Design Lab	-	-	-	-	-	25	25	50

The lab session includes **10 experiments.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advance. **An oral examination will be based on the overall syllabus**.

Suggested Experiments:

Sr. No.	Experiment Title
1	Use of Online Tools to study analog VLSI circuits
2	Analysis of MOSFETs for analog performance
3	Design and simulate various types of current mirror circuits
4	Design and simulate various common source amplifier circuits
5	Design and simulate various types of single stage amplifiers
6	Design and simulate differential amplifier
7	Design and simulate operational transconductance amplifier
8	Design and simulate mixed mode circuit

9	Generate layout for the simple and cascode current mirror
10	Generate layout for common source amplifier
11	Generate layout for the differential amplifier

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL703	Embedded GPU Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL703	Embedded GPU Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL703 (Embedded GPU) 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.

Course Outcomes:

After successful completion of the course students will be able to:
1. **Understand** basic programming and interfacing different I/Os.
2. **Understand** CUDA Kernel programming.
3. **Design** and implement algorithms using CUDA
4. **Design** and implement algorithms using OpenCL.

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

Suggested List of Experiments

Sr. No.	Experiment Title
1	GPIO programming (LED Blinking) on Jetson Nano.
2	Interfacing sensors and actuators to Jetson Nano.
3	Interfacing camera and modules with Jetson Nano.
4	To perform data classification using Jetson Nano.
5	Write a CUDA program to demonstrate squaring an array using CUDA kernel.
6	Write a CUDA C program to add two large vectors.
7	Design parallel algorithm for matrix multiplication using CUDA.
8	Write a CUDA program to find out minimum among 100 values using a CUDA kernel.
9	Write a OpenCL program for matrix multiplication.
10	Write a OpenCL program for calculating value of pi(π).

Note: Experiments can be performed online using simulation software as well as hardware.

(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.

Teachers are encouraged to develop a strong understanding of the subject using case studies for the design and development of projects based on GPU.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL703	**Artificial Intelligence 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					
ELL703	**Artificial Intelligence Lab**	--	--	--	--	--	**25**	**25**	**50**

Term Work:

At least 10 experiments covering the entire syllabus of ELL703 (Artificial Intelligence) 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.

Course Outcomes:

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

1. **Identify** suitable Agent Architecture for a given real world AI problem
2. **Implement** simple programs using Prolog.
3. **Implement** various search techniques for a Problem-Solving Agent.
4. **Represent** natural language description as statements in Logic and apply inference rules to it.
5. **Construct** a Bayesian Belief Network for a given problem and draw probabilistic inferences from it.

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

Suggested List of Experiments

Sr. No.	Experiment Title
1	Provide the PEAS description and TASK Environment for a given AI problem.
2	Identify suitable Agent Architecture for the problem
3	Write simple programs using PROLOG as an AI programming Language
4	Implement any one of the Uninformed search techniques
5	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
6	Implement adversarial search using min-max algorithm.
7	Implement any one of the Local Search techniques. E.g. Hill Climbing, Simulated Annealing, Genetic algorithm
8	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.
9	Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modelling Bayesian Networks)
10	Implement a Planning Agent
11	Design a prototype of an expert system
12	Case study of any existing successful AI system

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.

Useful Links:	
1	An Introduction to Artificial Intelligence - Course (nptel.ac.in)
2	https://tinyurl.com/ai-for-everyone
3	https://ai.google/education/
4	https://openai.com/research/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
Based on the entire syllabus	

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL703	Advanced Networking Technologies	--	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					
ELL703	Advanced Networking Technologies						25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL7034 (Advanced Networking Technologies) 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. Oral exams will be based on the entire syllabus.

Course Outcomes:

After successful completion of the course students will be able to:
1. **Analyse** the Wi-Fi Communication networks
2. **Implement** network security management tools
3. **Implement** networking tools using Linux.
4. **Evaluate** network performance based on various metrics.
5. **Design** and configure DHCP Protocol.
6. **Design and Study** Optical network.

Suggested List of Experiments

Sr. No.	Experiment Title
1	To study the security of cisco routers/switches port using Graphical Network Simulator (GNS).
2	To configure router with RIP protocol using GNS3
3	To configure and enable Dynamic Host Configuration Protocol (DHCP) on GNS3 router.
4	To Configure and enable TELNET server on GNS3 router.
5	Implementation of MPLs in Cisco Packet Tracer
6	To evaluate Network Performance and identify bottlenecks in the network.
7	Demonstrate Optical transport network
8	Simulation of optical network components.
9	Configuration of WDM network.
10	Simulation of SONET multiplexing
11	Demonstration of VPN using Cisco Packet Tracer
12	Implement the concept of wired LAN in NS-2

Note: Experiments can be performed online using virtual labs or NS2/GNS. Free simulation software on virtual labs can be used to perform the experiments.

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.

Teachers are encouraged to develop a strong understanding of the subject using case studies like the one shown in [1].

[1] Advanced Network Technologies Virtual Lab http://vlabs.iitkgp.ernet.in/ant/

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP701	Major Project – I	--	6#	--	--	3	--	3

# Indicates workload of Learner (Not Faculty)

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.					
ISP701	Major Project – I	--	--	--	--	50	--	50	100

Subject Code	Subject Name	Credits
ISP701	Major Project – I	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)

- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on log book	: 15
Marks awarded by review committee	: 15
Quality of Project report	: 20

Review/progress monitoring committee may consider following points for assessment.

- In VII semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

  - First shall be for finalization of problem
  - Second shall be on finalization of proposed solution of problem.

Assessment criteria of Major Project-I
Major Project-I shall be assessed based on following criteria;

1. Quality of survey/ need identification

2. Clarity of Problem definition based on need.

3. Innovativeness in solutions

4. Feasibility of proposed problem solutions and selection of best solution

5. Cost effectiveness

6. Societal impact

7. Innovativeness

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.

- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.

- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project-I shall be assessed based on following points;

1. Quality of problem and Clarity

2. Innovativeness in solutions

3. Cost effectiveness and Societal impact

4. Full functioning of working model as per stated requirements

5. Effective use of skill sets

6. Effective use of standard engineering norms

7. Contribution of an individual's as member or leader

8. Clarity in written and oral communication

Program Structure for Third Year Electronics Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pract. Tut.	Theory	Theory	Pract.	Total
ELC801	Industrial Automation	3	--	3	--	--	3
ELDO801	Department Optional Course – V	3	--	3	--	--	3
ELDO802	Department Optional Course – VI	3	--	3	--	--	3
ELIO801	Institute Optional Course - 2	3	--	3	--	--	3
ELL801	Industrial Automation Lab	--	2	--	--	1	1
ELL802	Department Optional Course – V Lab	--	2	--	--	1	1
ELP801	Major Project II	--	12#	--	--	6	6
Total		**12**	**16**	**12**		**8**	**20**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)	Term Work	Prac /oral	Total
		Test1	Test2	Avg					
ELC801	Industrial Automation	20	20	20	80	3	--	--	100
ELDO801	Department Optional Course – V	20	20	20	80	3	--	--	100
ELDO802	Department Optional Course – VI	20	20	20	80	3	--	--	100
ELIO801	Institute Optional Course - 2	20	20	20	80	3	--	--	100
ELL801	Industrial Automation Lab	--	--	--	--	--	25	25	50
ELL802	Department Optional Course – V Lab	--	--	--	--	--	25	25	50
ELP801	Major Project II	--	--	--	--	--	50	100	150
Total		**--**	**--**	**80**	**320**	**--**	**100**	**150**	**650**

Department Optional Courses:

Department Optional Course V (ELDO801)	Department Optional Course VI (ELDO802)
1. Microelectromechanical Systems (MEMS)	1. Next Generation Networks
2. Web Design	2. Industrial Internet of Things
3. Advanced Power Electronics	3. System on Chip
4. Virtual Instrumentation	4. Integrated Circuit Technology

Institute Optional Course – 2 (Semester- VIII)

ILO8021	Project Management	**ILO8026**	Research Methodology
ILO8022	Finance Management	**ILO8027**	IPR and Patenting
ILO8023	Entrepreneurship Development and Management	**ILO8028**	Digital Business Management
ILO8024	Human Resource Management	**ILO8029**	Environmental Management
ILO8025	Professional Ethics and Corporate Social Responsibility		

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC801	Industrial Automation	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC801	Industrial Automation	20	20	20	80	3	--	--	100

Course Objectives:

1. To impart knowledge about the fundamentals of automation and various automation systems used in industry.
2. To impart the knowledge about the architecture, working and applications of PLC, DCS and SCADA
3. To make the students understand the requirements of Safety Instrumented System (SIS).

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

1. **Describe** automation, need, importance and applications in industry
2. **Develop** PLC programs using ladder instructions for the process applications
3. **Explain** architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method.
4. **Describe** SCADA architecture, communication in SCADA
5. **Explain** database and alarm management system
6. **Recognize** the need of SIS and describe risk reduction methods

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Industrial Automation**	06
	1.1	Automation: definition, need importance, expectations and its applications, Types of automation-Process and factory automation, Types of Automation systems: fixed, programmable, flexible, integrated	
	1.2	Types of plant and control – categories in industry, open loop and closed loop control functions, continuous processes, discrete processes, and mixed processes, discrete controller, continuous Controller- P, I, D, PI and PID	
	1.3	Automation hierarchy – large control system hierarchy, data quantity and quality, hierarchical control	
2		**Programmable Logic Controller**	10
	2.1	Evolution of PLC, Definition, functions of PLC, advantages, architecture (hardware and software)- controller, input and output (I/O) modules, types of PLCs, working of PLC, scan time	
	2.2	Local and remote I/O expansion, special purpose modules, wiring diagrams of different input and output modules, communication modules, Memory and addressing- memory organization, I/O addressing, hardware to software interface	
	2.3	Introduction to PLC Programming, programming devices, PLC programming languages as per IEC standard, Ladder diagram (LD) programming-relay type, timer and counter, arithmetic, data comparison data transfer and program control instructions, advanced PLC instructions	
3		**Distributed Control System** (**DCS**)	08
	3.1	Introduction to DCS, generic architecture of DCS (hardware and software) -controller, I/O modules, communication module, data highway, local I/O bus, workstations.	
	3.2	Supervisory computer functions, DCS and Supervisory computer displays- group, detailed, trend and graphic, hierarchical computer system and their functionalities, network access protocols	
	3.3	Computer interface with DCS- hardware and software, Introduction to DCS Programming-Function Block Diagram method	
4		**Supervisory Control and Data Acquisition (SCADA)**	07
	4.1	Introduction-overview of SCADA system, brief history of SCADA, Features of SCADA, functionalities of SCADA system	
	4.2	Generic elements of SCADA system: central host computer, master terminal units (MTU), remote terminal unit(RTU), operator interface(Man machine interface), Data Communication components, methods, technologies, communication media and	

		protocol structure	
	4.3	Common applications and Industry specific applications of SCADA	
5		**Database and Alarm Management, MES, ERP**	**04**
	5.1	Introduction to Database management and alarm management system	
	5.2	Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Integration with enterprise system	
		Safety Instrumented System (SIS)	**04**
	6.1	Need for safety instrumented system, components of SIS,characteristics of SIS, risk and risk reduction methods, Process control systems andSIS, layers of protection	
6	**6.2**	Safety instrumented functions, Safety Integrity Levels, riskreduction factor and safety availability, functional safety standards	
		Total	**39**

Text Books:

1. Thomas Hughes, "Programmable Logic Controller", ISA Publication, 2001.
2. Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication, 1999.
3. Stuart A. Boyer, "SCADA: Supervisory Control and Data Acquisition", ISA Publication, 2010.
4. Gruhn and Cheddie, "Safety Shutdown Systems", ISA Publication, 1998.
5. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th edition, Prentice Hall of India, 2014.

Reference Books:

1. Bela G. Liptak, "Instrument Engineer's Handbook", Process control Chilton book, 3rd edition.
2. Krishna Kant, "Computer Based Process Control", Prentice Hall of India, 2nd edition, 2010.
3. Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
4. S.K. Singh, "Computer Aided Process Control", Prentice Hall of India, 2004.

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

End Semester Examination:
1. Question paper will 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO801	Micro-Electro-Mechanical-Systems	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					
ELDO801	Micro-Electro-Mechanical-Systems	20	20	20	80	3	--	--	100

Course Objectives:

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

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

1. **Derive** Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication
2. **Analyze** Draw various plots in time and frequency domain for the MEMS devices and **analyze** the system using the plots.
3. **Evaluate** the stability of micro-electro-mechanical- systems in time and frequency domain.
4. **Design** Design and simulate MEMS devices and system using standard simulation tools.
5. **Design** Develop different concepts of micro system sensors and actuators for real-world applications.
6. **Analyse** the behaviour of MEMS devices using simulation softwares

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

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to MEMS**	**04**
	1.1	Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications.	
2		**Understanding MEMS Materials & their Properties for Device Applications**	**07**
	2.1	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties for MEMS: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications.	
3		**MEMS Fab Processes – 1**	**07**
	3.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography. Advanced Lithography Techniques (EBL).**Understanding selection of Fab processes based on Applications**	
4		**MEMS Fab Processes – 2**	**08**
	4.1	Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining, DRIE, Die, Wire & Wafer Bonding, Dicing, Packaging. **Understanding selection of Fab processes based on Applications**	
5.		**MEMS Devices**	**08**
	5.1	Architecture, working and basic **quantitative** behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices	
		MEMS Sensors, Actuators and Structures	
	5.2	MEMS Sensing and actuation (Capacitive, Piezo electric Piezo resistive)	
6.		**MEMS Device Characterization**	**05**
	6.1	Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behaviour, MEMS Reliability.	
		Total	**39**

Text Books:

1. N. Maluf, K Williams;"An Introduction to Microelectromechanical Systems Engineering"; 2nd Ed -; Publisher: **Artech House Inc**
2. Ville Kaajakari "Practical MEMS "; Publisher: **Small Gear Publishing**
3. S. Senturia "Microsystem Design"; Publisher: **Springer**

Reference Books:

1. Minhang Bao, "Analysis and Design Principles of MEMS Devices"; Publisher: **Elsevier Science**
2. M. Madou, "Fundamentals of Microfabrication"; Publisher **CRC Press; 2 edition**
3. J. Allen, "Micro Electro Mechanical System Design"; Publisher: **CRC Press**
4. G. Kovacs, "Micromachined Transducers Sourcebook"; Publisher: **McGraw-Hill**
5. Wanjun Wang, Steven A. Soper," Bio-MEMS Technologies and Applications"; Publisher: **CRC Press**, First Edition.
6. -Tai-Ran HSU,"MEMS &Microsystems: Design And Manufacture"; Publisher **Tata McGraw-Hill**

Journals:
Refer to review papers in IEEE Journal of Microelectromechanical Systems.

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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO801	Web 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					
ELDO801	Web Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

Basics of programming languages, basic knowledge of HTML

Course Objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To implement client side scripting to static web pages.
3. To create dynamic web pages using server side scripting.
4. To use MVC framework for web application development.

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

1. **Design** static web pages using HTML5.
2. **Design** the layout of web pages using CSS3.
3. **Apply** the concepts of client side validation and scripts to static web pages using JavaScript and ReactJS.
4. **Build** responsive web pages using front-end framework Bootstrap.
5. **Build** dynamic web pages using server side scripting.
6. **Develop** a web application using appropriate web development framework.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to HTML5**	04
	1.1	Basic structure of an HTML5 document, Creating an HTML5 document, Mark up Tags, Heading-Paragraphs, line Breaks	
	1.2	HTML5 Tags - Introduction to elements of HTML, Working with Text, Lists, Tables and Frames, Hyperlinks, Images and Multimedia	
	1.3	HTML Forms and other HTML5 controls.	
		Self-Learning : HTML5 based game development	
2		**Designing Static Web Pages**	04
	2.1	Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Lists and Tables, CSS Id and Class, Box Model(Introduction, Border properties, Padding Properties, Margin properties)	
	2.2	CSS Advanced: Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector	
		Self-Learning : Creating page Layout and Site Designs	
3		**Client side scripting**	10
	3.1	**JavaScript** - Introduction to JavaScript, Lexical Structure, Types, Values, Variables, Expressions and Operators, Statements, Objects, Arrays, Functions, Pattern matching with regular expressions, JavaScript in Web Browsers, The Window object, Scripting Documents, Scripting CSS, Handling Events	
	3.2	**ReactJS**- Introduction to ReactJS, JSX, Class, Component, Props, Events, Conditionals, Lists, Forms, Router, Memo, CSS styling, Sass Styling, React Hooks	
		Self-Learning : UI/UX-SCSS, Typescript, Frontend-Angular, Backend-express	
4		**Bootstrap**	05
	4.1	Introduction to Bootstrap, downloading and installing Bootstrap.	
	4.2	The Grid System, CSS Foundations, Navigation Systems, JavaScript Effects.	
		Self-Learning: Bootstrap Customization-Combining Elements in Bootstrap, Customizing by Components, Plugins, and Variables	
5		**Server side-scripting**	10
	5.1	Introduction to PHP, PHP Tags, Adding Dynamic content, Accessing form variables, Identifiers, user-declared variables, Data types, Constants, Operators.	
	5.2	Control structures, Conditionals, Iteration constructs, Using arrays, string manipulation and regular expressions, reusing code and writing functions.	
	5.3	Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP.	
		Self-Learning: PHP-NoSQL Database connectivity e.g. PHP-MongoDB connectivity, NodeJS	
6		**Web Development Framework**	
	6.1	**MVC architecture -** Introduction and applications	06

	6.2	Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and Other Assets, Talking to the Database, Model Relations, Scopes, and Other Advanced Features, Integrating Web Forms, Authenticating and Managing Your Users, Deploying, Optimizing and Maintaining Your Application	
		Self-learning: Django Framework, Interactive web sites, web based information system, blogs, social networking sites, REST API and methods	
		Total	**39**

Text Books:

1. Ralph Moseley , M.T. Savliya , "Developing Web Applications", Willy India, Second Edition,
2. "Web Technology Black Book", Dreamtech Press, First Edition, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014.
   (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications.   https://ebooks-it.org/0470082801-ebook.htm
5. Jennifer Kyrnin, "SAMS Teach Yourself Bootstrap in 24 hours", 1st edition, Pearson Education.
6. Martin Bean, "Laravel 5 Essentials", PACKT Publishing Ltd
7. Kirupa Chinnathambi, "Learning React" , Addison-Wesley Professional

Reference Books:

1. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web - How To Program", Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and Atul Kahate, "Web Technologies", Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.
4. David Flanagan, "JavaScript: The Definitive Guide, Sixth Edition", O'Reilly Media, 2011
5. Steven Holzner, "The Complete Reference – PHP", Tata McGraw Hill, 2008
6. Mike Mcgrath, "PHP & MySQL in easy Steps", Tata McGraw Hill, 2012.
7. J. Millman and A. Grabel, "Head First HTML and CSS", 2nd edition, O" Reilly..
8. Ben Frain, "Responsive Web design with HTML5 and CSS3", PACKT Publishing Ltd.
9. L. Welling and L. Thomson, "PHP and MySQL Web Development", 4th edition, Adison Wesley Professional.

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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO801	Advanced Power Electronics	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					
ELDO801	Advanced Power Electronics	20	20	20	80	03			100

Course Prerequisites:

1. Electronic Devices and Circuits (ELC302)
2. Electrical Network Analysis (ELC304)
3. Power Electronics (ELC701)

Course Objectives:

1. To make students understand and appreciate analytical approach for design of power electronic systems.
2. To make students ready for research and development-oriented jobs in academia and industry by
3. Introducing recent research advancements in power electronic converters and their applications.

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

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

Module No.	Unit No.	Contents	Hrs.
1		**Analysis of Power Devices**	04
	1.1	Power transistor, Power MOSFET, SCR, IGBT, design of driver circuits for SCR, BJT, IGBT, MOSFET, selection criteria for switching devices.	
	1.2	EMI-EMC issues, protection circuits: Anti saturation protection for BJT and IGBT, overload protection, thermal protection.	
2		**Power Electronic Converters and Systems**	06
	2.1	Switching Voltage Regulators Introduction; Linear power supply (voltage regulators); Switching voltage regulators; unidirectional and bidirectional core excitation.	
	2.2	Review of basic dc-dc voltage regulator configurations Buck, Boost, Buck-Boost converters, Flyback converter, Bidirectional Converter (BDC) and their analysis for continuous and discontinuous mode	
3		**Modeling and Control of Power Electronic Systems**	06
	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, PI control for ACDC converters,.	
	3.2	PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis.	
4		**Power Electronic Converters**	08
	4.1	Introduction to 3-phase supply; 3-phase uncontrolled and controlled rectifier; 3-phase inverter.	
	4.2	Modeling and control of inverters: State space model of various dc to dc converters, state space averaging techniques, small signal analysis, transfer function, feedback control, compensator design, voltage mode control, current mode control.	
	4.3	Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques), neutral point clamped inverter, study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters: droop, and master and slave control.	
5		**Grid Interface of Renewable Energy Sources**	08
	5.1	Inverter interfacing control strategies for transferring wind and solar energy to grid, instantaneous power theory, reactive power control, synchronization with grid using phase-locked loop.	
	5.2	Concept of distributed generation system, microgrids, smart grids. Smart Grid Control.	
6		**Electric Motor Drives**	07
	6.1	Review of separately excited DC motor, Induction motor and Permanent magnet Synchronous motor (basic principle, equivalent circuit, speed-torque characteristics). Criteria for selecting drive components.	

	6.2	Single phase and three phase DC drives. Voltage and frequency control drive for Induction motor.	
		Total	**39**

Text Books:

1. N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.
2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.
3. P.S. Bhimbra, Power Electronics, Khanna Publishers, 2012.
4. M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw Hill

Reference Books:

1. P.C. Sen, Modern Power Electronics, Wheeler publications.
2. Ramamurthy, Thyristor & Their Applications.
3. S. Shrivastava, Power Electronics, Nandu publications, Mumbai.

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
ELDO801	Virtual Instrumentation	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks							
		Internal assessment			End Sem. Exam	Exam duration Hours	Term Work	Practical and Oral	Total
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELDO801	Virtual Instrumentation	20	20	20	80	3	--	--	100

Course Objectives:

1. To study graphical programming language for creating simulation and custom applications that interact with real-world data or signals in fields of science and engineering.

Course Outcomes:
After successful completion of the course students will be able to:
1. **Design** logical operations, using Graphical programming language.
2. **Develop** customized virtual instruments and represent them in required format with user friendly graphical programming software for LOOPS like FOR LOOP, WHILE LOOP etc.
3. **Understand** how to plot the generated data and also able to export the data outside the programming environment.
4. **Study** the data acquisition card or simulated software module and make user interface in the field of engineering.
5. **Describe** the concepts of different analysis tool.
6. **Design and develop** real world applications using graphical programming software.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	4
	1.1	Virtual Instrumentation: Historical perspective, block diagram and Architecture of a virtual instrument	
	1.2	Conventional Instruments versus Virtual Instruments	
	1.3	Data-flow techniques, graphical programming in data flows.	
2		**VI Programming Techniques**	10
	2.1	Data types, VIs and sub-VIs, Structures (For, While etc.) arrays, clusters, shift registers, case and sequence structures, formula nodes.	
	2.2	Debugging techniques.	
3		**Plot and Export Data**	4
	3.1	Strings, File I/O	
	3.2	Plotting data: graphs and charts, report generation.	
4		**Data Acquisition**	6
	4.1	Introduction to data acquisition on PC, Digital I/O, Counters and Timers	
	4.2	Software and Hardware installation, Calibration, Resolution	
	4.3	Data acquisition interface requirements, VISA programming	
5		**Measurement Analysis Tools**	6
	5.1	Use of analysis tools for measurement of max, min, peak to peak voltage, Time period of signal, correlation methods	
	5.2	Design of oscilloscope, digital multimeter.	
6		**Applications**	9
	6.1	System development for a process. Development of Graphical User Interface (GUI).	
	6.2	Implementation of various controllers (ON/OFF control, PID control) for a process.	
		Total	**39**

Text Books:

1. Rober Bishop, "Learning with LabVIEW TM 7 express", Pearson Education, 2005.

Reference Books:

1. Jovitha Jerome, "Virtual Instrumentation", PHI, 2018.
2. Gupta S, "Virtual Instrumentation Using LabVIEW", Tata McGraw Hill Publishing Company Limited.
3. Lisa K. Wells &Jettrey Travis, "LabVIEW for everyone", Prentice Hall, New Jersey, 1997.
4. LabVIEW users manual.

Website: www.ni.com

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:

- Question paper will consist of 6 questions, each of 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
- 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
ELD0802	Next Generation Networks	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					
ELD0802	Next Generation Networks	20	20	20	80	3	--	--	100

Prerequisite:
Computer Communication Network
Digital Communications
Principles of Communication Engineering

Course Objectives:

1. To learn about Personal Area Networks
2. To understand Vehicular Ad-hoc Networks
3. To explore WiMAX standards
4. To learn Networking with IPv6
5. To understand the need for 5G

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

1. Appreciate the requirement of Personal Area Networks
2. Analyze the need for VANET
3. Understand the requirement for WiMAX .
4. Evaluate networking with IPv6
5. Comprehend the need for 5G

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

Module No.	Unit No.	Contents	Hrs.
1		**Personal Area Networks**	06
	1.1	**Bluetooth Ad Hoc Network :**Introduction, Bluetooth network structure, Bluetooth protocol stack , Bluetooth physical layer, Bluetooth MAC layer, Modified versions of Bluetooth, Advantages, drawbacks and applications .	
	1.2	**Wireless Personal Area Networks: Low Rate and High Rate:** ZigBee Technology, IEEE 802.15.4 LR-WPAN Device Architecture, IEEE 802.15.3a — Ultra WideBand, Advantages, drawbacks and applications.	
	1.3	**Wireless Sensor Networks:** Introduction to Wireless Sensor Networks, Wireless Sensor Network Model, Sensor Network Protocol Stack.	
2		**VANET**	08
	2.1	**Introduction to Vehicular Adhoc Network** Traffic Monitoring, Causes of Congestion, Commonly used sensor technology, Detection Methods.	
	2.2	**Modes for Traffic Flow and Vehicle Motion** Models for longitudinal Vehicle movement, Lane Change situations, Simulating Vehicle to Vehicle and Infrastructure to Vehicle Communications.	
	2.3	**Networking Issues in VANET:** Routing Protocols for VANET	
3		**WiMAX standards**	06
	3.1	WiMAX architecture, WiMAX physical layer, WiMAX MAC layer	
	3.2	WiMAX security Aspects	
4		**Networking with IPv6**	08
	4.1	Routing with IPv6 :OSPF for IPv6, PIM-SM & DVMRP for IPv6 IPv4/IPv6 Transition Mechanism	
	4.2	Tunneling: Automatic Tunneling & Configured tunneling	
5		**5G Technology**	06
	5.1	5 G : Difference between 4G and 5G, 5G Architecture, Planning of 5G Network	
	5.2	Quality of Service, Radio Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization.	
6		**Case Studies**	
		NGN Networks: Perspectives and Potentials, Virtual Global Exhibition. Virtual Classroom, e-Education and Experimental Laboratory, Virtual Corporate Environment, Virtual Home, Virtual Hospital.	05
		Total	39

Text Books:

1. Vijay Garg, Wireless Communications & Networking, The Morgan Kaufmann Series in Networking
2. Hassnaa Moustafa and Yan Zhang, Vehicular Networks :Techniques, Standards and Applications, Auerbach Publications,2019
3. Upena Dalal , Wireless Communication and Networks , Oxford Higher Education

Reference Books:

1. K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India,.
2. Deven Shah , Ambavade, "Advanced Communication Networking"
3. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO802	Industrial Internet of Things	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					
ELDO802	Industrial Internet of Things	20	20	20	80	03	-	-	100

Pre-Requisites: Internet of things, Web technologies, Industrial Automation

Course Objectives:

1. To learn and understand the importance of IoT in Industrial applications.
2. To understand how IoT has become a game changer in the new economy where the customers are looking for integrated value.
3. To apply the IoT concepts in building solutions to Industrial problems.
4. To learn and understand the tools and techniques that enable IoT solutions and Security aspects.

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

1. Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
2. Explore IoT technologies, architectures, standards and regulation
3. Apply IoT Protocols for Industrial automation/applications
4. Explain the need of IoT in Industrial environment & Security aspects of IoT
5. Explain the new concepts for data logging and analytics

Module No.	Unit No.	Contents	Hrs.
1		**Introduction & Architecture**	03
	1.1	What is IIoT and the Connected world?	
	1.2	SCADA Vs. IoT	
	1.3	Architecture of IIoT	
	1.4	IoT node, Challenges of IIoT	
2		**IIT Components**	08
	2.1	Fundamentals of Control System: Introduction, Components, Closed loop & Open loop system.	
	2.2	Sensors and Interfacing: Introduction to Sensors, Classification, Role of Sensors in IIoT, Various types of Sensors, Special requirements for IIoT sensors	
	2.3	Concepts of Normally Open/ Normally Closed I/O, Analog controlled Valves eg. Current to Pressure Converters.	
	2.3	Role of Actuators, Types of Actuators.	
	2.4	Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M etc.	
3		**Communication Protocols**	08
	3.1	RS485/RS232 Communication Protocols MODBUS RTU Vs. MODBUS TCP/IP Importance of using MODBUS in IIOT Applications	
	3.2	Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID	
	3.3	Protocols converters : USB to RS485, 4-20mA to RS485, MQTT vs. MQTTS	
	3.4	Cloud / Server architectural requirements for IIOT Applications, Internet vs. Intranet	
4		**Control & Supervisory Level of Automation**	06
	4.1	Programmable logic controller (PLC)	
	4.2	Control signal introduction, Digital I/O, Analog I/O, 4-20mA systems	
	4.3	Supervisory Control & Data Acquisition (SCADA)	
	4.4	Need of Human machine Interface (HMI) in Automation	
	4.5	Basics of Enterprise Resource Planning (ERP) System & Manufacturing Execution System (MES)	
5		**Security Issues in IIOT**	08
	5.1	Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis	
	5.2	IoT Security tomography and layered attacker model,	
	5.3	Security model for IoT, Network security techniques Management aspects of cyber security.	
6		**Applications of IIOT**	06

	6.1	Case study of Smart Energy Monitoring Application	
	6.2	Case study of Chemical Tank Level Monitoring application through HMI	
	6.3	Case study on IIOT cloud integration with Microsoft Azure, AWS & other cloud services like Ubidots or Thingspeak	
		Total	**39**

Text Books:

1. Introduction to Industrial Internet of Things and Industry 4.0, 1st Edition, Sudip Misra, CRC Press.
2. Practical Industrial Internet of Things Security: A practitioner's guide to securing connected Industries, Sravani Bhattacharjee.
3. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Willy Publication.
4. Architecting the Internet of Things, by Florian Michahelles, Springer, 2011.

Reference Books:

1. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.), Springer Publication.
2. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, Springer Publication.
3. 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 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
ELDO802	System on Chip	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					
ELDO802	System on Chip	20	20	20	80	3	--	--	100

Course Objectives:

1. To know the basic concepts of System on Chip
2. To understand SoC design with respect to Processor Architecture, Memory, Interconnect and Tradeoffs
3. To be familiar with basics of SoC Customization and Configuration

Course Outcomes:

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

1. **Understand** overview of SoC System Architecture
2. **Select** Processor for a SoC
3. **Develop** knowledge of memory and interconnect design for SoC
4. **Apply** the knowledge of design tradeoffs for optimized SoC performance
5. **Describe** SoC Customization and Configuration

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

Module No		Detailed Contents	Hrs.
1		**Introduction to SoC and System Approach**	8
	1.1	Overview of System Architecture: Components of a System: Processor, Memory and Interconnects, Basic SoC Model, Hardware and Software: Programmability versus Performance	
	1.2	Processor Architectures: Functional view approach, Architectural view approach	
	1.3	Memory and Addressing: Architecture of Memory and Memory for SoC operating Systems	
	1.4	System Interconnects: Bus based and NoC based interconnect Approach An Approach for SOC Design	
2		**Processor Architecture for SoC**	6
	2.1	Processor Selection: Overview and Processor Core Selection	
	2.2	Basic concepts in Processor Microarchitecture; Basic elements in Instruction Handling: Decoding, Bypassing and Executionunit	
	2.3	Introduction to Robust Architectures	
3		**Design Trade off and minimizing delays and cost**	6
	3.1	Design Tradeoff: Time, Area and Power, reliability and Configurability,	
	3.2	Buffers: Minimizing Pipeline Delays	
	3.3	Branches: Reducing Branch Cost	
4		**Memory Design**	8
	4.1	Overview: Outline for Memory Design, SoC external Flash Memory And internal memory placement, Size tradeoff	
	4.2	Scratch pad and Cache Organization: Write Policies, Strategies for Line Replacement at miss time, Multilevel Caches, L1-Icache L1-Dcache	
	4.3	Memory Address Translation: Translation of Virtual to Real, TLB	
5		**Interconnect Design**	6
	5.1	Overview of Interconnect Architectures	
	5.2	Bus Architectures: Arbitration, Bridge and Bus Structure	
	5.3	Standard Buses: AMB Aand Core Connect Bus	
6		**Customization and Configuration**	5
	6.1	Introduction: Estimating Effectiveness of Customization	
	6.2	Overview of SoC Customization	
	6.3	Customizing Instruction Processors	
	6.4	Introduction to Reconfigurable concept	
		Total	**39**

Text Books:

1. Michael J. Flynn and Wayne Luk, Computer System Design System-on-Chip, Wiley India Pvt. Ltd.
2. SteveFurber, ARM System on Chip Architecture,2ndEdition,2000, Addison Wesley Professional

Reference Books:

1. Ricardo Ries, Design of System on a Chip: Devices and Components, 1stEdition, 2004, Springer
2. Jason Andrews, Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Newnes, BK and CDROM.
3. 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			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELDO802	IC Technology	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					
ELDO802	IC Technology	20	20	20	80	3	--	--	100

Preamble:

This course enables students to understand semiconductor manufacturing requirements and various techniques for crystal growth and will get clear understanding of various MOS fabrication processes along with CMOS fabrication process flow. Students will be able to design layouts of MOS based Circuits.

Course Objectives:

1. To provide knowledge of fundamental building blocks of IC fabrication
2. To design basic CMOS circuit layouts using Lambda design rules
3. To be familiar with various VLSI technologies and novel devices

Course Outcome:

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

1. **Explain** crystal growth techniques
2. **Demonstrate** a clear understanding of various MOS fabrication processes
3. **Discuss** CMOS fabrication process flow
4. **Design** basic CMOS circuits with layout
5. **Study** various VLSI technologies and novel devices

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

Module No.	Unit No.	Contents	Hrs.
1		**Semiconductor manufacturing requirements and Crystal growth techniques**	06
	1.1	Semiconductor Manufacturing: Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering	
	1.2	Crystal growth techniques: Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2		**Semiconductor Device Fabrication Processes-1 (Epitaxy, Oxidation and Deposition)**	08
	2.1	**Epitaxy:** Introduction to Epitaxy concept	
	2.2	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality **Device Isolation:** LOCOS, Shallow Trench Isolation (STI)	
	2.3	**Deposition:** Physical Vapor Deposition-Evaporation and Sputtering systems, Chemical Vapor Deposition: APCVD, LPCVD, PECVD systems	
3		**Semiconductor Device Fabrication Processes-2 (Impurity incorporation, Pattern Transfer and Contacts)**	10
	3.1	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems **Ion Implantation:** Penetration range-Nuclear& Electronic stopping and Range, Implantation damage, Annealing-Rapid thermal annealing, Ion implantation systems.	
	3.2	**Etching:** Basic concepts and Classification **Lithography:** Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.3	**Metallization and Contacts:** Introduction to Metallization, Schottky contacts and Ohmic contacts	
4		**CMOS Process Flow and Design rules**	08
	4.1	**CMOS Process Flow:**N well, P-well and Twin tub, CMOS Latch Up	
	4.2	**Design rules**: Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
5		**VLSI Technologies**	04
	5.1	**SOI Technology:** SOI structures, fabrication methods and features	
	5.2	**Advanced Technologies:** low κ and high κ, BiCMOS, Introduction to MESFET Technology	
6	6	**Novel Devices**	03
	6.1	**Multigate Devices:** Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire).	
	6.2	**Nanowire:** Concept, VLSI method of fabrication, Nanowire FETs	
	6.3	**CNT FET:** Introduction to Graphene and CNTFET structure	
		Total	39

Text Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.
2. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, StudentEdition

Reference Books:

1. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 2nd Edition
2. G. S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition
3. Kerry Bernstein and N. J. Rohrer, "SOI Circuit Design Concepts", Kluwer Academic Publishers, 1st edition.
4. Jean-Pierre Colinge, "FinFETs and Other Multigate Transistors", Springer, 1st 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
ILO8021	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.					
ILO8021	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. • 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… 1. Apply selection criteria and select an appropriate project from different options. 2. Write work break down structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically. 4. Use Earned value technique and determine & predict status of the project. 5. Capture lessons learned during project phases and document them for future reference

Module	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. **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. **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. **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, 7[th]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 (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
ILO8022	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.					
ILO8022	Finance Management	20	20	20	80	-	-	-	100

Course Objectives	• Overview of Indian financial system, instruments and market • Basic concepts of value of money, returns and risks, corporate finance, working capital and its management • Knowledge about sources of finance, capital structure, dividend policy
Course Outcomes	Student will be able to… 1. Understand Indian finance system and corporate finance 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. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	6
3	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	9

	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.	
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 (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
ILO8023	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				
		Test 1	Test 2	Avg.					
ILO8023	Entrepreneurship Development and Management	20	20	20	80	-	-	-	100

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

Module	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 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 **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 (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
ILO8024	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.					
ILO8024	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. • To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective. • To familiarize the students about the latest developments, trends & different aspects of HRM. • To acquaint the student with the importance of behavioral skills, Inter-personal, inter- group in an organizational setting. • To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of
Course Outcomes	Learner will be able to… 1. Gain knowledge and understand the concepts about the different aspects of the human resource management. 2. Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture. 3. Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment. 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** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in	10

	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, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013,
   Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

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
ILO8025	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.					
ILO8025	Professional Ethics and Corporate Social Responsibility	20	20	20	80	-	-	-	100

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

Module	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 **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. 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 (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
ILO8026	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.					
ILO8026	Research Methodology	20	20	20	80	-	-	-	100

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

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 **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem	08

	c. Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
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, (2nd ed), Singapore, Pearson Education

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			
	IPR and Patenting (abbreviated as IPRP)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO8027		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.					
ILO8027	IPR and Patenting	20	20	20	80	-	-	-	100

Course Objectives	- To understand intellectual property rights protection system - To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures - To get acquaintance with Patent search and patent filing procedure and - applications
Course Outcomes	Student will be able to… - understand Intellectual Property assets - assist individuals and organizations in capacity building - 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. **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 **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	07

	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	
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 **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 (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
ILO8028	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.					
ILO8028	Digital Business Management	20	20	20	80	-	-	-	100

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

Module	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	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**M Materializing e-business: From Idea to Realization**-Business plan preparation **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 (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
ILO8029	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.					
ILO8029	Environmental Management	20	20	20	80	-	-	-	100

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

Module	Contents	Hours
1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, the Energy scenario.	10
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	05
4	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. 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 (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			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL801	Industrial Automation Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL801	Industrial Automation Lab	---	--	--	--	--	25	25	50

Term Work:

At least six experiments and two assignments covering the entire syllabus of ELC801 (Industrial Automation) 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/Oral exams will be based on the entire syllabus.

Course Outcomes:

After successful completion of the course students will be able to:
1. **Describe** automation, need, importance and applications in industry and **design**proportional, integral and derivative controller
2. **Develop** PLC programs using LD instructions for any batch process application
3. **Use** Function Block Diagram to simulate analog and digital functions of any process
4. **Design** graphical user interface for any SCADA applications
5. **Discuss** the role of database, alarm management system, ERP and MES
6. **Recognize** the need of safety instrumented system

Suggested List of Experiments

Sr. No.	Experiment Title
1	Study/ Simulate proportional, integral and derivative controller
2	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic
3	Develop PLC programs for minimum 2 applications e.g Heating, mixing, car parking , elevator system , traffic control system etc.
4	Simulate analog and digital function blocks of DCS using Functional Block Diagram
5	Develop graphical user interface (GUI) for any continuous or batch process plant
6	Develop GUI for any one application using SCADA software
7	Assignment/Exercise based on Automation Fundamentals
8	Assignment/Exercise based on DCS Displays and hierarchical computer control
9	Assignment /Exercise based on SCADA
10	Assignment/Exercise based on Database and Alarm management/MES/ERP
11	Assignment/Exercise based on Safety Instrumented System

Note: Experiments can be performed online using simulation software as well as hardware.

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
ELL802	Micro-Electro-Mechanical-Systems Laboratory	--	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					
ELL802	Micro-Electro-Mechanical-Systems Laboratory	--	--	--	--	--	25	25	50

Term Work:

At least 07 experiments and 01 Case Study covering the entire syllabus of ELL802 (Micro-Electro-Mechanical-Systems Laboratory) 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.

Course Outcomes:

After successful completion of the course students will be able to:
1. **Analyse** MEMS devices behaviour.
2. **Design** a performance specification for MEMS Devices based on the applications
3. **Develop** A clear understanding of how a MEMS device will function
4. **Evaluate** The performance parameters of MEMS device in time and frequency domain
5. **Design** A stable MEMS device for a typical application

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

Suggested List of Experiments

Sr. No.	Experiment Title
1	Design electro-statically actuated cantilever.
2	Design bimorph cantilever which act as pressure sensor.
3	Dynamic analysis of Beam
4	Find the tip deflection of the cantilever with different types of load.
5	Find the tip deflection of the cantilever in sweep analysis
6	Model and simulate Electro-mechanical actuator. Do dc and transient analysis.
7	Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature.
8	Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam
9	Model and simulate MEMS accelerometer
10	Simulate the dynamic behaviour of pressure sensor.

Note: Faculty members are required to take Case study of MEMS based devices and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices under case study.

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
ELL802	Web 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					
ELL802	Web Design Lab	--	--	--	--	--	25	25	50

Term Work:

Term work will consist of lab experiments testing all the technologies according to the syllabus of subject Web Design (ELDO801) through solving an appropriate problem. Students are expected to pick up one case study/Mini Project on innovative solution to real world problem and perform all the experiments based on that.

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.

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

1. **Design** static web pages using HTML5.
2. **Design** the layout of web pages using CSS3.
3. **Apply** the concepts of client side validation and scripts to static web pages using JavaScript and ReactJS.
4. **Build** responsive web pages using front-end framework Bootstrap.
5. **Build** dynamic web pages using server side scripting.
6. **Develop** a web application using appropriate web development framework.

Suggested List of Experiments

Sr. No.	Experiment Title
1	Installation and Setting of LAMP / WAMP / XAMP
2	Develop a Prototype of the selected problem statement (UI and UX).
3	Design and Implement web pages using HTML5 and CSS3 on the selected problem statement.
4	Design Form using JavaScript/HTML/ReactJS with client side validations on the selected problem statement.
5	Design Interactive web pages using PHP (any framework) with database connectivity to MySQL on the selected problem statement.
6	Design and Implement web pages with PHP and Ajax on the selected problem statement.
7	Enhance the web page designed in experiment number 2 using bootstrap.
8	Mini Project on innovative problem statement.

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
ELL802	Advanced Power Electronics 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					
ELL802	Advanced Power Electronics Lab						25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL802 (**Advanced Power Electronics**) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Title
1	To study speed control of a DC motor using DC drive.
2	To study speed control of a DC motor using AC drive.
3	To study step up /step down chopper.
4	To demonstrate high frequency induction heating using a Multisim simulator.
5	To study 3 phase half controlled rectifier with R load.
6	To simulate a sinusoidal PWM inverter using Simulink.
7	To study speed torque characteristics of AC drive using MATLAB.
8	To study grid connected single-phase inverters.

| 9 | To study cascaded H-bridge multilevel inverters. |
| 10 | To study closed-loop control of buck converters. |

Note: All the experiments can be performed online using simulation softwares. 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
ELL802	Virtual Instrumentation 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					
ELL802	Virtual Instrumentation Lab						25	25	50

Term Work:

At least 10 experiments covering the entire syllabus of ELL501 (Virtual Instrumentation) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. 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.

Course Outcomes:
After successful completion of the course students will be able to:
1. **Design** logical operations, using Graphical programming language.
2. **Develop** customized virtual instruments and represent them in required format with user friendly graphical programming software for LOOPS like FOR LOOP, WHILE LOOP etc.
3. **Understand** how to plot the generated data and also able to export the data outside the programming environment.
4. **Study** the data acquisition card or simulated software module and make user interface in the field of engineering.
5. **Describe** the concepts of different analysis tool.
6. **Design and develop** real world applications using graphical programming software.

Suggested List of Experiments

Sr. No.	Experiment Title	
1	To develop a VI to calculate speed, convert degree Celsius to Fahrenheit.	CO1
2	To develop a Sub VI to implement Half adder and Full Adder.	CO2
3	To develop VI using FOR and WHILE loop to add 10 numbers, calculate Factorial of a given number.	CO2
4	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.	CO2
5	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.	CO2
6	Applications of Graphical Programming Software in digital eletronics - binary to decimal conversion etc.	CO1, CO2
7	To develop a VI for storing all the points of simulated signal using File I/Os	CO3
8	Build a VI to plot circle in XY graph, generate and plot random numbers on chart, different colors in an intensity graph etc with graph, chart properties and options.	CO3
9	Measurement of AC/DC voltage and current using DAQ cards.	CO4
10	Develop the VI to turn LEDs ON/OFF using DAQ devices (Arduino, Raspberry Pi etc.)	CO4
11	Applications of Graphical Programming Software in control - simulate first and second order system response, effect of damping factor etc.	CO5
12	To create VI to simulate traffic light controlusing Sequence structure.	CO6

Note: Experiments can be performed using National Instruments LabVIEW Software.

> *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.*

Practical/Oral Examination:

Practical Examination will be based on performing one experiment in the laboratory from the list of experiments given in the syllabus & the oral examination will be based on subject ISL Virtual Instrumentation Lab.

Term Work:

Term work shall consist of minimum 10 programs from the list of suggested programs.

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP801	Major Project – II	--	12#	--	--	6	--	6

# Indicates workload of Learner (Not Faculty)

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.					
ISP801	Major Project – II	--	--	--	--	100	--	50	150

Subject Code	Subject Name	Credits
ISP801	Major Project – II	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)

- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

  o   Marks awarded by guide/supervisor based on log book   : 30
  o   Marks awarded by review committee   : 30
  o   Quality of Project report   : 40

Review/progress monitoring committee may consider following points for assessment.

- In VIII semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Assessment criteria of Major Project-II
Major Project-II shall be assessed based on following criteria;

1. Cost effectiveness and Societal impact

2. Full functioning of working model as per stated requirements

3. Effective use of skill sets

4. Effective use of standard engineering norms

5. Contribution of an individual's as member or leader

6. Clarity in written and oral communication

Guidelines for Assessment of Major Project Practical/Oral Examination:
- Report should be prepared as per the guidelines issued by the University of Mumbai.

- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.

- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

  Major Project shall be assessed based on following points:

1 Quality of problem and Clarity

2 Innovativeness in solutions

3 Cost effectiveness and Societal impact

4   Full functioning of working model as per stated requirements

5   Effective use of skill sets

6   Effective use of standard engineering norms

7   Contribution of an individuals as member or leader

8   Clarity in written and oral communication

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