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		**Reasoning Under Uncertainty**	**5**
	5.1	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**	**7**
	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.	
	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**	
		Cloud Applications:	
	6.1	**Scientific Applications**: **Healthcare:** ECG analysis in cloud **IoT-enabled Cloud Applications:** Smart Agriculture	**6**
		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 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split- Plot Designs.	7
4	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	7
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	7
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	4

Books Recommended:

Reference Books:

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

Assessment:

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

Theory Examination:

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO7015	Operation Research (abbreviated as OR)	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
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… 1. To identify and describe present state of energy security and its importance. 2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	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