Vivekanand Education Society's
Institute of Technology
(Affiliated to University of Mumbai, Approved by AICTE & Recognized by Govt. of Maharashtra)

Department of Electronics and Computer Science

Academic Year 2023-24

Semester III and Semester IV

Program Structure for Second Year Electronics and Computer Science

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Practical/ Tutorial	Theory	Practical	Tutorial	Total
ECC 301	Engineering Mathematics III	3	1*	3	-	1	4
ECC 302	Electronic Devices	3	-	3	-	-	3
ECC 303	Digital Electronics	3	-	3	-	-	3
ECC 304	Data Structures and Algorithms	3	-	3	-	-	3
ECC 305	Database Management Systems	3	-	3	-	-	3
ECL 301	Electronic Devices Lab	-	2	-	1	-	1
ECL 302	Digital Electronics Lab	-	2	-	1	-	1
ECL 303	Data Structures and AlgorithmsLab	-	2	-	1	-	1
ECL 304	Database Management Systems lab	-	2	-	1	-	1
ECL 305	Skill base Lab - OOPM: (C++ and Java)	-	4	-	2	-	2
ECM 301	Mini Project -1A	-	4	-	2	-	2
	Total	15	16	15	08	1	24

* Tutorial must be conducted batchwise

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ECC 301	Engineering Mathematics III	20	20	60	2	25	-	125
ECC 302	Electronic Devices	20	20	60	2	-	-	100
ECC 303	Digital Electronics	20	20	60	2	-	-	100
ECC 304	Data Structures and Algorithms	20	20	60	2	-	-	100
ECC 305	Database Management Systems	20	20	60	2	-	-	100
ECL 301	Electronic Devices Lab	-	-	-	-	25	25	50
ECL 302	Digital Electronics Lab	-	-	-	-	25	25	50
ECL 303	Data Structures and AlgorithmsLab	-	-	-	-	25	25	50
ECL 304	Database Management Systems lab	-	-	-	-	25	25	50
ECL 305	Skill base Lab - OOPM: (C++ and Java)	-	-	-	-	50	-	50
ECM 301	Mini Project -1A	-	-	-	-	25	25	50
	Total	100	100	300	-	200	125	825

Course Code:	Course Title	Credit
ECC 301	**Engineering Mathematics-III**	**5**

Prerequisite:	
Course Objectives:	
1	To build a strong foundation in mathematics, provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
2	To prepare student to apply reasoning informed by the contextual knowledge to engineering practice, to work as part of teams on multi-disciplinary projects.
Course Outcomes:	
1	Apply Laplace transform and its properties to find the transform of a given function and evaluate some integrals of real value function.
2	Solve problems on finding inverse Laplace transform of given functions and apply to solve initial and boundary value problems associated with ordinary differential equations.
3	Expand a periodic function as a Fourier series in terms of sine and cosine functions
4	Construct an analytic function from a harmonic function, obtain a family of orthogonal trajectories. Plot the image of a curve under a complex transformation from z-plane to w-plane.
5	Evaluate integration of complex variable functions using the knowledge of Cauchy integral formula, residue of singular points. Apply Cauchy residue theorem to evaluate some integrals of real value functions
6	Evaluate directional derivative, gradient, divergence, curl. Solve problems on line, surface and volume integrals applying Green's, Stoke's and Gauss divergence theorem.

Module No.	Unit No.	Contents	Hrs.
1		**Laplace Transform**	6
	1.1	Definition and Condition of Existence of Laplace transform	
	1.2	Laplace transform of standard functions like polynomial, exponential, sine, cosine and hyperbolic.	
	1.3	Properties of Laplace transform: Linearity, First Shifting, Second Shifting, Change of Scale, Multiplication by t, Division by t, Laplace Transform of derivative, integral and convolution of two functions.	
	1.4	Evaluation of real improper integrals by using Laplace transformation	
2		**Inverse Laplace Transform**	6
	2.1	Definition and Inverse Laplace transform of standard functions	
	2.2	Inverse Laplace transform using Partial fractions, derivatives property.	
	2.3	Inverse Laplace transform using Convolution property.	
	2.4	Applications to solve initial and boundary value problems involving Ordinary differential equations.	
3		**Fourier Series:**	6
	3.1	Drichlet's conditions, Definition of Fourier series and Parseval's Identity.	
	3.2	Fourier series of periodic function with period and	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
4		**Function of Complex Variables:**	6
	4.1	Function of complex variable f(z), Limit, Continuity and Differentiability of f(z), Analytic function. Necessary and sufficient conditions for f(z) to be Analytic. Cauchy-Riemann equations in Cartesian and Polar coordinates.	
	4.2	Milne-Thomson method: Determine analytic function f(z) when real part (u), imaginary part (v) or its combination is given.	
	4.3	Harmonic function, Harmonic conjugate and Orthogonal trajectories	
5		**Complex Integration:**	8
	5.1	Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions, Cauchy's Integral formula.	
	5.2	Taylor's and Laurent's series expansion.	

	5.3	Definition of Singularity, Zeroes, Poles of f(z), Residues, Cauchy's Residue Theorem.	
	5.4	Application of Residue Theorem to evaluate integration of some real value functions.	
6		**Vector Differential and Integral Calculus:**	**7**
	6.1	Gradient, Directional derivative, Divergence and Curl. Solenoidal and irrotational (conservative) vector fields.	
	6.2	Line Integral (path dependent and independent), Work done, Conservative vector fields, Scalar potential.	
	6.3	Green's theorem in a plane, Surface integral, Stoke's theorem.	
	6.4	Volume integral, Gauss divergence Theorem.	
		Total	39

Textbooks:	
1	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
Reference Books:	
1.	Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2.	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3.	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 (totalling to 20 marks) of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ECC 302	**Electronic Devices**	3

Course Objectives:	
1	To deliver the knowledge and enhance comprehension capabilities of students through understanding of electronic devices.
2	To analyze amplifiers using BJT and FET .
3	To perform low frequency and high frequency analysis of single stage amplifier.
4	To study and understand concept of rectifiers and filters.
Course Outcomes: After successful completion of the course students will be able to:	
1	Explain the working of semiconductor devices.
2	Interpret the characteristics of semiconductor devices.
3	Analyze Electronics circuits using BJT .(DC & AC analysis)
4	Analyze Electronics circuits using FET. (DC & AC analysis)
5	Analyze low frequency and high frequency response of single stage amplifier.
6	Understand concept of rectifiers and filters.

Module No.	Unit No.	Contents	Hrs.
1		**P-N Junction Diode & Applications**	**05**
	1.1	Theoretical description of basic structure & construction, symbol, operation under zero bias, forward bias & reverse bias, avalanche breakdown, V-I characteristics & temperature effects (no mathematical analysis or numerical examples)	
	1.2	Application of P-N junction diode as clippers & clampers (different types of configurations with input-output waveforms & transfer characteristics)	
2		**Special Semiconductor Devices**	**06**
	2.1	Zener diode as the voltage regulator (theoretical description only which includes construction of circuit diagram, operation / working for varying DC input voltage & varying load resistance, concept of line regulation & load regulation.(no numerical examples)	
	2.2	Construction, structure, symbol, operating principle, working & V-I characteristics of special semiconductor devices such as Varactor diode, Schottkey diode, Photodiode, Light emitting diode (LED) & Solar cells.	
3		**Bipolar Junction Transistor (BJT)**	**08**
	3.1	BJT construction & structure, symbol, operation, voltages & currents, V-I characteristics of common emitter (CE), common base (CB) & common collector (CC) configuration, Early effect.	
	3.2	DC Circuit Analysis: DC load line, Q-point & region of operation, common BJT configuration (Only CE amplifier),concept of biasing, bias stability, analysis of CE amplifier using voltage divider biasing circuit. (numerical examples to be included)	
	3.3	AC Analysis of BJT Amplifiers: AC load line, small signal model: hybrid-pi model. AC equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE amplifier using hybrid-pi model only. (numerical examples to be included)	
4		**Field Effect Devices (FET)**	**09**
	4.1	JFET: Construction, symbol, operation, V-I & transfer characteristics MOSFET: Construction, operation, symbol, V-I & transfer characteristics of the D-MOSFET & E-MOSFET (theoretical description only for JFET & MOSFET)	
	4.2	DC Circuit Analysis: DC load line, Q-point & region of operation, common MOSFET configurations of common source (CS), common drain (CD) & common gate (CG), analysis of biasing circuits (only CS configuration using voltage divider biasing) (numerical examples only for E-MOSFET & D-MOSFET; no JFET)	

	4.3	AC Analysis: AC load line, small signal (AC) model of the MOSFET & its equivalent circuit, small signal (AC) analysis of common source (CS) configuration MOSFET amplifier only (numerical examples included)	
5		**Frequency Response of Amplifiers**	**06**
	5.1	Low frequency response & analysis, effect of the coupling, bypass & load capacitances on single stage MOSFET amplifier for common source (CS) configuration (mathematical analysis & numerical examples included)	
	5.2	High frequency response & analysis, effect of parasitic capacitances in MOSFET amplifier, high frequency equivalent circuit of MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth (mathematical analysis & numerical examples included)	
6		**Rectifiers & Filters**	**05**
	6.1	Rectifiers: Working of full – wave center tapped rectifier & bridge type rectifier, expressions for the DC /average & RMS of output voltage and output current, ripple factor.	
	6.2	Filters: Capacitor (C), Inductor (L), Inductor – Capacitor (LC), C-L-C (π) with circuit diagram, waveforms, working / operation & expression for ripple factor (theoretical description only – no analysis or numerical examples to be included)	
		Total	**39**

Textbooks:	
1	Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition.
2	Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, “Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.
3	James Morris & Krzysztof Iniewski, Nano-electronic Device Applications Handbook by CRC Press.
Reference Books:	
1	Boylestead," Electronic Devices and Circuit Theory", Pearson Education
2	David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3	Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4	S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill.
5	Millman and Halkies, “Integrated Electronics”, Tata McGraw Hill.

Internal Assessment:

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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ECC 303	**Digital Electronics**	3

Prerequisite :	
Course Objectives:	
1	To understand various number systems codes and to introduce students to various logic gates, SOP, POS form and their minimization techniques.
2	To teach the working of combinational circuits, their applications and implementation of combinational logic circuits using MSI chips.
3	To teach the elements of sequential logic design, analysis and design of sequential circuits.
4	To understand various counters and shift registers and its design using MSI chips.
5	To explain and describe various logic families and Programmable Logic Devices.
6	To train students in writing programs with Verilog hardware description languages.
Course Outcomes: After successful completion of the course students will be able to:	
1	Perform code conversion and able to apply Boolean algebra for the implementation and minimisation of logic functions.
2	Analyse, design and implement Combinational logic circuits.
3	Analyse, design and implement Sequential logic circuits.
4	Design and implement various counter using flip flops and MSI chips.
5	Understand TTL & CMOS logic families, PLDs, CPLD and FPGA.
6	Understand basics of Verilog Hardware Description Language and its programming with combinational and sequential logic circuits.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Digital Design**	
	1.1	Number Systems and Codes: Review of Number System, Binary Code, Binary Coded	07
	1.2	Codes: Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
	1.3	Logic Gates and Boolean Algebra: Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables	
2		**Combinational Circuits using basic gates as well as MSI devices**	
	2.1	Arithmetic Circuits: Half adder, Full adder, Ripple carry adder, Carry Look ahead adder, Half Subtractor, Full Subtractor, multiplexer, cascading of Multiplexer, demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1).	07
	2.2	MSI devices: IC7483, IC74151, IC74138, IC7485.	
3		**Elements of Sequential Logic Design**	
	3.1	Sequential Logic: Latches and Flip-Flops. RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops.	07
	3.2	Counters: Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counter, Twisted ring counter, Shift Registers, Universal Shift Register.	
4		**Sequential Logic Design:**	
	4.1	Sequential Logic Design: Mealy and Moore Machines, clocked synchronous state machine analysis, state reduction techniques (inspection, partition and implication chart method) and state assignment, sequence detector, Clocked synchronous state machine design.	07
	4.2	Sequential logic design practices: MSI counter (IC 7490) and MSI Shift register (IC 74194) and their applications.	
5		**Logic Families and Programmable Logic Devices**	
	5.1	Logic Families: Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND, Operation of TTL NAND gate.	04

	5.2	Programmable Logic Devices: Concepts of PAL and PLA, Introduction to CPLD and FPGA architectures. *(NO Numerical expected)*	
6		**Introduction to Verilog HDL**	
	6.1	Basics: Introduction to Hardware Description Language and its core features, synthesis in digital design, logic value system, data types, constants, parameters, wires and registers. Verilog Constructs: Continuous & procedural assignment statements, logical, arithmetic, relational, shift operator, always, if, case, loop statements, Gate level modelling, Module instantiation statements.	**07**
	6.2	Modelling Examples: Combinational logic eg. Arithmetic circuits, Multiplexer, Demultiplexer, decoder, Sequential logic eg. flip flop, counters.	
		Total	**39**

Textbooks:	
1	R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2	Morris Mano, Digital Design, Pearson Education, Asia 2002.
3	J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing, 2018.
Reference Books:	
1	Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2	John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.
3	Stephen Brown and ZvonkoVranesic, Fundamentals of digital logic design with Verilog design, McGraw Hill, 3rd Edition.
4	Digital Circuits and Logic Design – Samuel C. Lee, PHI
5	William I.Fletcher, “An Engineering Approach to Digital Design”, PrenticeHall of India.
6	Parag K Lala, “Digital System design using PLD”, BS Publications, 2003.
7	Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 2004.

Internal Assessment:

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

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Data Structures and Algorithms

Course Code:	Course Title	Credit
ECC 304	Data Structures and Algorithms	3

Prerequisite: Knowledge of one or more programming language e.g. C, C++. JAVA, Python and proficiency in any one of them.	
Course Objectives:	
1	To understand and demonstrate basic data structures (such as Arrays, linked list, stack, queue, binary tree, graph).
2	To Implement various operations on data structures.
3	To study different sorting and searching techniques.
4	To choose efficient data structures and apply them to solve real world problems.
Course Outcomes:	
1	Implement various linear data structures.
2	Implement various nonlinear data structures.
3	Select appropriate sorting and searching techniques for a given problem and use it.
4	Develop solutions for real world problems by selecting appropriate data structure and algorithms.
5	Analyse the complexity of the given algorithms.

Module	Contents	Hrs
1	**Introduction to Data Structures**	04
	Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array,Static arrays vs Dynamic Arrays, structures. Introduction to Analysis of Algorithms, characteristics of algorithms, Time and Space complexities, Asymptotic notations. Arrays, Pointers and Strings: Introduction to Arrays, Definition, One Dimensional Array and Multidimensional Arrays, Pointer, Pointer to Structure, various Programs for Array and Pointer. Strings. Introduction to Strings, Definition, Library Functions of Strings.	
2	**Stack and Queues**	08
	Introduction, Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue, queue-Round Robin Algorithm.	
3	**Linked List**	08
	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List (SLL), Operations on Singly Linked List: Insertion, Deletion,reversal of SLL, Print SLL. Implementation of Stack and Queue using Singly Linked List. Introduction to Do Representation of a Queue using array, Circular Queue, concept of priority Queue, Applications of Qubly Linked List and Circular Linked List	
4	**Trees**	08
	Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree Operations on Binary Search Tree, Applications of Binary Tree – Expression Tree, Huffman Encoding.	
5	**Graphs**	04
	Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting.	
6	**Introduction to Sorting and Searching**	07

6	Introduction to Searching: Linear search, Binary search, Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort, Complexity Analysis of Algorithm, Comparison of sorting Techniques based on their complexity. Hashing Techniques, Different Hash functions, Collision & Collision resolution techniques: Linear and Quadratic probing, Double hashing.	
	Total	**39**

Textbooks:	
1	Data Structures Using C, Aaron M Tenenbaum, YedidyahLangsam, Moshe J Augenstein, Pearson Education
2	Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G.Sorenson
3	Data Structures using C, Reema Thareja, Oxford
4	C and Data structures, Prof. P.S.Deshpande, Prof. O.G.Kakde, Dreamtech Press.
5	Data Structures: A Pseudocode Approach with C, Richard F. Gilberg& Behrouz A. Forouzan, Second Edition, CENGAGE Learning
Reference Books:	
1	Data Structure Using C, Balagurusamy.
2	Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3	ALGORITHMS Design and Analysis, Bhasin, OXFORD.
4	Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
5	Computer Algorithms by Ellis Horowitz and Sartaj Sahni, Universities Press.
6	Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Internal Assessment:

1) **Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.**
2) **Mid Term test is to be conducted when approx. 50% syllabus is completed.**
3) **Duration of the midterm test shall be one hour.**

Continuous Assessment:-

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Sr. No	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	**10 marks**
2.	Wins in the event/competition/hackathon	**10 marks**
3.	Content beyond syllabus presentation	**10 marks**
4.	Creating Proof of concept	**10 marks**
5.	Mini Project / Extra Experiments/ Virtual Lab	**10 marks**
6.	GATE Based Assignment test/Tutorials etc	**10 marks**
7.	**Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)**	**05 marks**
8.	**Multiple Choice Questions (Quiz)**	**05 marks**

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Database Management System

Course Code:	Course Title	Credit
ECC 305	Database Management System	3

Course Objectives:	
1	Develop entity relationship data model and its mapping to relational model
2	Learn relational algebra and formulate SQL queries
3	Apply normalization techniques to normalize the database
4	Understand concepts of transaction, concurrency control and recovery techniques
Course Outcomes:	
1	Recognize the need of database management system
2	Design ER and EER diagram for real life applications
3	Construct relational model and write relational algebra queries.
4	Formulate SQL queries
5	Apply the concept of normalization to relational database design.
6	Describe the concepts of transaction, concurrency and recovery.

Module No.	Unit No.	Contents	Hrs
1		**Introduction to Database Concepts**	03
	1.1	Introduction, Characteristics of databases	
	1.2	File systems v/s Database systems	
	1.3	Data abstraction and Data Independence	
	1.4	DBMS system architecture	
	1.5	Database Administrator	
2		**Entity–Relationship Data Model**	07
	2.1	The Entity-Relationship (ER) Model	
	2.2	Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys	
	2.3	Relationship constraints: Cardinality and Participation	
	2.4	Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		**Relational Model and Relational Algebra**	06
	3.1	Introduction to the Relational Model	
	3.2	Relational schema and concept of keys	
	3.3	Mapping the ER and EER Model to the Relational Model	
	3.4	Relational Algebra – operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	06
	4.1	Overview of SQL	
	4.2	Data Definition Commands	
	4.3	Integrity constraints: Key constraints, Domain Constraints, Referential integrity, Check constraints	
	4.4	Data Manipulation commands, Data Control commands	

	4.5	Set and string operations, aggregate function - group by, having	
	4.6	Views in SQL, joins, Nested and complex queries, Triggers	
	4.7	MYSQL Functions	
5		**Relational–Database Design**	07
	4.1	Pitfalls in Relational-Database designs	
	4.2	Concept of normalization	
	4.3	Function Dependencies	
	4.4	First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	10
	6.1	Transaction Concept, Transaction states	
	6.2	ACID properties	
	6.3	Transaction Control Commands	
	6.4	Concurrent Executions	
	6.5	Serializability:Conflict and View	
	6.6	Concurrency Control: Lock-based, Timestamp-based protocols	
	6.7	Recovery System: Log based recovery	
	6.8	Deadlock handling	
		Total	39

Textbooks:	
1	Korth, Slberchatz,Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2	Elmasri and Navathe, Fundamentals of Database Systems, 5th Edition, Pearson education
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
Reference Books:	
1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5th Edition.
2	Dr.P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	G. K. Gupta, Database Management Systems, McGraw Hill., 2012

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4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Electronic Devices Lab

Lab Code	Lab Name	Credit
ECL 301	**Electronic Devices Lab**	**1**

Prerequisite:	
Lab Objectives:	
1	To deliver a hands-on approach for studying electronic devices.
2	To comprehend characteristics of electronic devices; thereby understanding their behavior.
3	To analyze and calculate inherent parameters of electronic devices through an experimental approach.
4	To introduce modern software simulation tools for modeling & simulation of electronic devices.
Lab Outcomes:	
1	Explain the working of semiconductor devices.
2	Interpret the characteristics of semiconductor devices.
3	Analyze electronics circuits using BJT and FET. (DC & AC analysis)
4	Simulate basic circuits using electronic devices through software simulation.
5.	Compare various biasing circuits and configurations of BJT and MOSFETs.
6	Analyze frequency response of amplifier.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Hardware Experiment Name**
1	To study passive(R, L,C) and active (BJT, MOSFET) components.
2	To study equipment (CRO, Function Generator, Power supply).
3	To perform characteristics of PN junction diodes.
4	To perform Clippers and Clampers.
5	To perform analysis and design Fixed bias, Voltage divider bias for CE amplifier.
6	To perform CE amplifiers as voltage amplifiers (Calculate Av, Ai, Ri, Ro).
7	To perform CS MOSFET amplifier as voltage amplifier and measurement of its performance parameters.
8	To perform Full wave/Bridge rectifier with LC/pi filter.
9	To perform Zener as a shunt voltage regulator.
10	To implement a single stage MOSFET CS amplifier and study its frequency response.

List of Simulation Experiments

Sr. No.	**Simulation Experiment Name**
1	SPICE simulation of and implementation for junction analysis.
2	SPICE simulation of and implementation for BJT characteristics.
3	SPICE simulation of and implementation for JFET characteristics.
4	SPICE simulation of MOSFET characteristics.
5	SPICE simulation of Full wave/Bridge rectifier with LC/pi filter.
6	SPICE simulation of CE amplifier.
7	SPICE simulation of CS MOSFET amplifier.
8	SPICE simulation of single stage MOSFET CS amplifier and study its frequency response.

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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 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)
Continuous assessment exam	
1	Based on the subject and related lab of **ECC 302** and **ECL 301**

Lab Code	Lab Name	Credit
ECL 302	**Digital Electronics Lab**	**1**

Prerequisite:	
Lab Objectives:	
1	To learn the functionality of basic logic gates.
2	To construct combinational circuits and verify their functionalities.
3	To learn the functionality of flip flops and their conversion.
4	To design and implement synchronous and asynchronous counters, Shift registers using MSI
5	To simulate various combinational and sequential circuits and analyze the results using Verilog HDL.
Lab Outcomes:	
1	Learn the functionality of basic logic gates and implement Boolean functions.
2	construct combinational circuits and verify their functionalities.
3	verify the functionality of various flip flops and perform flip flop conversion.
4	design and implement counter and shift registers using MSI.
5.	simulate various combinational and sequential circuits and analyze the results using Verilog HDL.

Term Work:

At least 10 experiments (60 % Hardware based + 40 % Simulation Base) covering the entire syllabus of ECC 303 (Digital Logic Circuits) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and 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 Hardware Experiments

Sr. No.	Experiment Name
1	To verify different logic gates and implement basic gates using universal gates.
2	To implement Boolean function in SOP and POS form.
3	To implement half adder, full adder, half Subtractor, full Subtractor.
4	To implement BCD adder using binary adder IC 7483.
5	To implement logic equations using Multiplexer IC 74151.
6	To verify the comparator IC 7485.
7	To verify truth table of SR, JK, T and D flip flops.
8	To perform Flip flop conversion JK to D, JK to T and D to T flip flop.
9	To implement MOD N counter using IC 7490.
10	To implement universal shift register using IC 74194.

List of Simulation Experiments

Sr. No.	Experiment Name
1	To simulate basic logic gates using Verilog HDL.
2	To design and simulate Full adder/full subtractor using Verilog HDL.
3	To design and simulate Multiplexer/Demultiplexer using Verilog HDL.
4	To design and simulate decoder 74138 using Verilog HDL.
5	To design and simulate comparator IC 7485 using Verilog HDL.
6	To simulate basic flip flops using Verilog HDL.
7	To design and simulate 4-bit counter / up-down counter using Verilog HDL.
8	To design and simulate Shift register using Verilog HDL.

(Implementation of any of above using FPGA/CPLD)

Database Management System Lab Work

Lab Code	Lab Name	Credit
ECL 304	**Database Management Systems Lab**	**1**

Lab Outcomes:	
1	Design ER /EER diagram and convert to relational model for the real world application.
2	Apply DDL, DML, DCL and TCL commands.
3	Write simple and complex queries
4	Use PL/SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions

10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

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.

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 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)
Continuous Assessment Exam	
1	Based on the subject and related lab

Course Code:	Course Title	Credit
ECL 305	Skill base Lab - OOPM: (C++ and Java)	3

Prerequisite: ● Fundamentals of C-Programming ● Control Structures ● Arrays and String	
Lab Objectives:	
1	To understand Object Oriented Programming basics and its features.
2	To understand and apply Object Oriented Programming (OOP) principles using C++
3	Able to implement Methods, Constructors, Arrays, Multithreading and Applet in java
4	Able to use a programming language to resolve problems.
Lab Outcomes:	
1	Use C++ in programming.
2	Use different control structures.
3	Understand fundamental features of an object-oriented language: object classes and interfaces, exceptions and libraries of object collections.
4	Understand Java Programming.
5.	To develop a program that efficiently implements the features and packaging concept of java in the laboratory.
6	To implement Exception Handling and Applets using Java.

Module No.	Unit No.	Contents	Hrs.
1		**C++ Overview**	04
	1.1	Basic Concepts of Object-Oriented Programming, C++ programming Basics, Data Types, Structures, Enumerations, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2		**C++ Control Structures**	03
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
3		**Object-Oriented Programming using C++**	10
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4		**Introduction to Java**	05
	4.1	Programming paradigms- Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule-based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5		**Inheritance, Polymorphism, Encapsulation using Java**	10
	5.1	**Classes and Methods:** class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value,	

		constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter,returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java	
	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6		**Exception Handling and Applets in Java**	**07**
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception subclasses). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	(Self study)	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**39**

Textbooks:	
1	Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education, 2000.
2	Deitel, “C++ How to Program”, 4th Edition, Pearson Education, 2005.
3	D. T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition, 2015.
4	Yashwant Kanitkar, “Let Us Java”, BPB Publications, 4nd Edition, 2019.
Reference Books:	
1	Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, 10th Edition,2017.
2	Harvey M. Deitel, Paul J. Deitel, Java: How to Program, 8th Edition, PHI, 2009.
3	Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education.
4	Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010

Software Tools:

Sr. No	Software Tools:
1	**Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/**
2	Eclipse: https://eclipse.org/
3	Netbeans:https://netbeans.org/downloads/
4	CodeBlock:http://www.codeblocks.org/
5	J-Edit/J-Editor/Blue J

Online Repository:

Sr. No	Online Repository:
1	Google Drive
2	GitHub
3	Code Guru

Suggested Experiments: Students are required to complete at least 20 experiments.	
Sr. No	**C++ Programs**
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance

10	Create a class for students to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No	JAVA Programs
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from the user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using a while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Term Work:	
1	Term work should consist of 16 experiments.
2	Journal must include at least 4 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 50 Marks (Experiments: 35-marks, Attendance Theory & Practical: 05-marks, Assignments: 10-marks)
Continuous assessment exam	
1	Based on the subject and related lab of **ECL 305**

Mini Project - 1A

Course Code:	Course Title	Credit
ECM 301	**Mini Project - 1 A**	**2**

Course Objectives:	
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:	
1	Identify analyze and solve problems based on societal /research needs in a group.
2	Develop interpersonal skills to work as member of a group or leaderand and demonstrate project management principles during project work
3	Draw the proper inferences from available results through theoretical /experimental /simulations.
4	Use standard norms of engineering practices.
5.	Excel in written and oral communication.
6	Demonstrate capabilities of self-learning in a group, which leads to life-long learning

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini 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 mini 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 Institute.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first 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.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalization of problem and proposed solution
    - Second shall be for implementation and testing of solution.

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of the solution. (Innovative/out of box solution)

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey
a) Survey of Existing system
b) Limitations of Existing system or research gap
c) Problem Statement and Objective
d) Scope

iv. Proposed System
a) Analysis/Framework/ Algorithm
b) Details of Hardware & Software
c) Design details
d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Along with the project report a folders of project documentation, all literature survey papers, implemented code, required software, utilities, used component details, user manual etc, is to be submitted.

Assessment criteria of Mini Project.

Mini Project 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. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini- project.

In case of half year project all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

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

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Program Structure for Second Year Electronics and Computer Science

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Practical	Theory	Practical	Tutorial	Total
ECC 401	Engineering Mathematics - IV	3	1*	3	-	1	4
ECC 402	Electronic Circuits	3	-	3	-	-	3
ECC 403	Control and Instrumentation	3	-	3	-	-	3
ECC 404	Microprocessors and Microcontrollers	3	-	3	-	-	3
ECC 405	Discrete Structures and Automata Theory	3	-	3	-	-	3
ECL 401	Electronic Circuits Lab	-	2	-	1	-	1
ECL 402	Control and Instrumentation Lab	-	2	-	1	-	1
ECL 403	Microprocessors and Microcontrollers Lab	-	2	-	1	-	1
ECL 404	Skill- base Lab: Python programming	-	2	-	2	-	2
ECM 401	Mini Project -1 B	-	4$	-	2	-	2
	Total	15	14	15	07	1	23

* Tutorial must be conducted batchwise
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Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ECC 401	Engineering Mathematics - IV	20	20	60	2	25	-	125
ECC 402	Electronic Circuits	20	20	60	2	-	-	100
ECC 403	Control and Instrumentation	20	20	60	2	-	-	100
ECC 404	Microprocessors and Microcontrollers	20	20	60	2	-	-	100
ECC 405	Discrete Structures and Automata Theory	20	20	60	2	-	-	100
ECL 401	Electronic Circuits Lab	-	-	-	-	25	25	50
ECL 402	Control and Instrumentation Lab	-	-	-	-	25	25	50
ECL 403	Microprocessors and Microcontrollers Lab	-	-	-	-	25	25	50
ECL 404	Skill- base Lab: Python programming	-	-	-	-	50	-	50
ECM 401	Mini Project -1 B	-	-	-	-	25	25	50
	Total	100	100	300	-	175	100	775

Course Code:	Course Title	Credit
ECC 401	**Engineering Mathematics-IV**	**4**

Prerequisite:	
Course Objectives:	
1	To build a strong foundation in mathematics, provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
2	To prepare student to apply reasoning informed by the contextual knowledge to engineering practice, to work as part of teams on multi-disciplinary projects.
Course Outcomes:	
1	Find Eigen values, Eigen vectors of matrix, apply Caley Hamilton theorem to find a function of a matrix, distinguish derogatory matrix, and diagonalizable matrix.
2	Reduce a quadratic for to canonical forms using congruent and orthogonal transformations and characterize it on the basis of rank, index and class value.
3	Identify a vector spaces and its basis. Calculate norm, inner products, establish related properties. Find an orthogonal and orthonormal basis using Gram Schmidt process.
4	Compute probability using probability distribution of discrete and continuous Random variable, Poisson and Normal distribution.
5	Apply Testing of Hypothesis associated with Sampling distribution of large sample, small sample and chi square distribution.
6	Apply the concept of Correlation and Regression, fitting of curve to the given data sets.

Module No.	Unit No.	Contents	Hrs.
1		**Linear Algebra (Theory of Matrices):**	6
	1.1	Eigen values and Eigen vectors, and properties	
	1.2	Cayley-Hamilton Theorem(without proof), verification and reduction of higher degree polynomials.	
	1.3	Derogatory and non-derogatory matrices, Functions of Square Matrix.	
	1.4	Similarity of matrices, diagonalizable and non-diagonalizable matrices.	
2		**Linear Algebra (Quadratic Forms):**	5
	2.1	Quadratic forms over real field, Linear transformation of Quadratic form,Reduction of Quadratic form to canonical forms (diagonal and normal) using a congruent transformation.	
	2.2	Rank, Index and Signature of quadratic form, Sylvester's law of inertia,Value-class of a quadratic form-Definite, Semi-definite and Indefinite.	
	2.3	Reduction of Quadratic form to a canonical forms (diagonal and normal) using an orthogonal transformation. Singular Value Decomposition.	
3		**Linear Algebra (Vector Space, Basis and Orthonormal Basis):**	7
	3.1	Vector spaces over real field, subspaces.	
	3.2	Vectors in n-dimensional vector space, Linear combinations, Linear dependence and independence set of vectors, Basis of a vector space.	
	3.3	Norm, Inner product, distance between two vectors, angle between two vectors, orthogonal vectors, Triangular and Cauchy-Schwarz inequality.	
	3.4	Orthogonal and orthonormal Basis, Gram-Schmidt process to construct an orthonormal Basis.	
4		**Probability:**	8
	4.1	Discrete and continuous random variable with probability distribution and probability density function.	
	4.2	Expectation, Variance, Moment generating function, Raw and central Moments, Covariance, Correlation coefficient and their properties.	

	4.3	Probability Distribution: Binomial, Poisson and Normal distribution.	
5		**Probability Distribution and Sampling Theory**	**8**
	5.1	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Test of significance of mean and difference between the means of two samples for Large samples	
	5.2	Degree of freedom, Student's t-distribution, Test of significance of mean and difference between the means of two samples for Small samples	
	5.3	Chi-Square Test: Test of goodness of fit. Contingency table and Test of independence of attributes, Yate's Correction	
6		**Statistical Techniques:**	**5**
	6.1	Karl Pearson's coefficient of correlation (r).	
	6.2	Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks).	
	6.3	Fitting of first and second degree curves.	
	6.4	Lines of regression.	
		Total	**39**

Textbooks:	
1	Linear Algebra and its Applications, D. C. Lay, Pearson.
2	Gupta and Kapoor, Fundamental of Mathematical Statistics, S Chand
Reference Books:	
1.	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education
2.	Howard Anton and Chris Rorres, Elementary Linear Algebra with Supplemental Applications, Wiley

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 (totalling to 20 marks) of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Electronic Circuits

Course Code:	Course Title	Credit
ECC 402	**Electronic Circuits**	3

Course Prerequisite:ECC 302:Electronic Devices.	
Course Objectives:	
1	To teach fundamental concepts of multistage amplifiers.
2	To teach fundamental principles of differential amplifiers.
3	To teach fundamental principles of operational amplifiers.
4	To develop an overall approach for students from selection of integrated circuit, specification, functionality and applications.
Course Outcomes: After successful completion of the course students will be able to:	
1	Analyze the performance of multistage amplifiers.
2	Analyze differential amplifiers for various performance parameters.
3	Express mathematically the performance parameters in terms of circuit parameters.
4	Choose an appropriate circuit for the given specifications/ applications.
5	Describe various applications and circuits based on operational amplifiers.
6	Design an application with the use of integrated circuits.

Module No.	Unit No.	Contents	Hrs.
1		**Multi stage Amplifiers**	06
	1.1	Introduction to multi-stage amplifiers – need & necessity, different types of couplings (DC, R-C & transformer) with advantages & disadvantages.	
	1.2	DC and AC analysis of CS-CS , CS-CG amplifier and darlington pair amplifier (numerical examples to be included)	
2		**Differential Amplifiers**	07
	2.1	MOSFET current sources,Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, small signal (AC) analysis of only dual input balanced output (DIBO) for differential mode gain & common mode gain, common mode rejection ratio (CMRR) & input resistance / impedance	
	2.2	MOSFET differential amplifier with an active load (theoretical description & only mathematical analysis – no numerical examples)	
3		**Operational Amplifiers**	05
	3.1	The ideal operational amplifier (op-amp), internal block diagram of op-amp, characteristics of op-amp, ideal & practical op-amp parameters / specifications (no detailed description or any analysis), mathematical model of op-amp, IC 741 op-amp with pin diagram & description	
	3.2	Operational amplifier open loop & closed loop configurations (theoretical description only), the concept of virtual ground & virtual short	
4		**Applications of Operational Amplifier**	09
	4.1	Types of negative feedback – voltage series, voltage shunt, current series & current shunt (theoretical description only), the op-amp inverting amplifier & op-amp non-inverting amplifier (mathematical analysis for derivation of output voltage only,numerical examples & designing)	
	4.2	Adder, summing amplifier, averaging circuit, subtractor, integrator (ideal), differentiator (ideal), difference amplifier, current amplifier & 3 op-amp instrumentation amplifier (only mathematical analysis for derivation of output voltage with numerical examples & designing included)	
	4.3	Current to voltage converters (I to V) & voltage to current converters (V to I) – floating load & grounded load (mathematical analysis only – no numericals)	
5		**Oscillators &Comparators**	07
	5.1	Oscillators: RC phase shift oscillator, Wien bridge oscillator & the crystal oscillator (theoretical description only – no mathematical analysis), numerical example & design problem on RC phase shift oscillator & Wien bridge oscillator	

	5.2	Waveform Generators: Square wave generator & triangular wave generator (only theoretical description – no mathematical analysis or designing examples)	
	5.3	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector (ZCD) & Schmitt Trigger (numerical examples on the inverting Schmitt Trigger for both symmetrical & non-symmetrical configurations)	
6		**Special Purpose Integrated Circuits**	05
	6.1	IC 555 timer internal block diagram & pin configuration, operation in astable & monostable multivibrator with mathematical analysis & numerical examples.	
	6.2	ADC 0808 / 0809 , DAC 0808 (theoretical description only)	
		Total	**39**

Textbooks:	
1	Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition.
2	Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.
Reference Books:	
1	Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
2	David A. Bell,“Electronic Devices and Circuits”, Oxford, Fifth Edition.
3	Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4	S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill.
5	D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.
6	Sergio Franco, “Design with operational amplifiers & analog integrated circuits”, Tata McGraw Hill, 3rd edition
7	William D. Stanley, “Operational Amplifiers with Linear Integrated Circuits”, Pearson, 4th Edition

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ECC 403	**Controls and Instrumentation**	3

Course Prerequisite: 1. Basic Electrical Engineering 2. Applied Mathematics (Laplace transform, ordinary differential equations) 3. Applied Physics	
Course Objectives:	
1	To develop the ability to model control systems and determine their time response and frequency response.
2	To develop the ability to analyze stability of control systems.
3	To develop the ability to understand instruments and data acquisition systems.
Course Outcomes: After successful completion of the course students will be able to:	
1	Derive the transfer functions for the given control systems.
2	Analyze the performance of control systems based on the time domain and frequency domain specifications.
3	Judge the stability of the given control systems using appropriate stability criteria.
4	Understand and explain the working principle of sensors and transducers.
5	Explain various parameters of data acquisition systems.
6	Describe instrument communication standards.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Control Systems and Mathematical Models**	7
	1.1	Introduction to control systems: The control system, servomechanisms, digital control.	
	1.2	Mathematical models: Transfer functions, block diagram algebra, block diagram reduction, signal flow graphs.	
2		**Time response analysis and stability analysis in time domain**	7
	2.1	Time response analysis: standard test signals, time response of first and second order systems, steady state errors and error constants.	
	2.2	Stability in time domain: The concept of stability, necessary conditions for stability,Hurwitz stability criterion, Routh stability criterion.	
	2.3	Stability analysis using root locus technique.	
3		**Stability Analysis in frequency domain and Introduction to advances in control systems.**	7
	3.1	Introduction to frequency response analysis, correlation between time and frequency domain.	
	3.2	Stability analysis using Bode plots.	
	3.3	Nyquist stability criterion and stability analysis using Nyquist plot.	
	Self Study	**Introduction to advances in control systems:Adaptive control, Introduction to distributed control systems.**	
4		**Sensors and Transducers**	6
	4.1	Introduction to sensors and transducers. Various types of sensors. Various types of transducers and their principle of operation. Selection criteria of transducers.	
	4.2	Displacement and pressure transducers: potentiometers, pressure gauges, Linear variable differential transducer (LVDT), strain gauges.	
	4.3	Temperature transducers: working principle, ranges and applications of resistance temperature detectors (RTD), thermocouple and thermistor temperature transducers.	
5		**Signal conditioning DAS, Data logger and SCADA**	6
	5.1	Introduction to instrumentation systems, data acquisition system (DAS), use of DAS in Intelligent instrumentation system. Design of pressure and temperature measurement system using DAS. Data logger, its types and applications. SCADA-communication architecture, types, applications	
6		**Telemetry and Instrument communication standards**	6

	6.1	Introduction to telemetry, landline telemetry, radio telemetry and types of multiplexing.	
	6.2	Instrument interfacing, Current loop, RS232/485, Field bus, Modbus, GPIB, USB Protocol, and HART communication Protocol.	
		Total	**39**

Textbooks:	
1	I. J. Nagrath, M. Gopal, "Control System Engineering", 5th edition, New Age International Publishers.
2	B. S. Manke, "Linear Control Systems", Khanna Publishers, New Delhi.
3	D. Patranabis, "Principle of Industrial Instrumentation", Tata McGraw Hill.
4	A.K. Sawhney, "Electrical & Electronic Measurement & Instrumentation" – DRS. India.
5	H.S.Kalsi, "Electronic Instrumentation"-TMH, 2nd Edition.
Reference Books:	
1	K. Ogata, "Modern Control Engineering", PHI, New Delhi.
2	Norman S. Nise, "Control System Engineering", John Wiley and Sons.
3	B. C. Kuo, "Automatic Control Systems", PHI, New Delhi.
4	C. S. Rangan, G. R. Sharma and V. S. Mani, 'Instrumentation Devices and Systems', Tata McGraw-Hill Publishing Company Ltd.
5	Helfrick & Cooper, "Modern Electronic Instrumentation & Measuring Techniques" – PHI

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ECC 404	**Microprocessors and Microcontrollers**	3

Course Prerequisites:	
1. Electronic Devices	
2. Digital Electronics	
Course Objectives:	
1	To study the concepts and basic architecture of a Microprocessor and Microcontroller.
2	To write Assembly language programs for Microprocessors and Microcontrollersfor various applications.
3	To know the importance of different peripheral devices and their interfacing to 8086 and 8051.
4	To build Microprocessor and Microcontroller based systems.
Course Outcomes: After successful completion of the course students will be able to:	
1	Explain 16-bit Microprocessor architectures
2	To develop Assembly language programming skills for Microprocessors
3	To design and implement Microprocessor based systems.
4	Explain 8-bit Microcontroller architecture and differentiate between Microprocessor and Microcontrollers
5	To develop Assembly and C language programming skills for Microcontrollers.
6	To interface I/O peripherals with Microcontroller systems.

Module No.	Unit No.	Contents	Hrs.
1		**The 8086 Microprocessor**	06
	1.1	8086 Architecture	
	1.2	Memory Segmentation and Memory Banking	
	1.3	8086 pin description	
	1.4	Interrupts and Interrupt service routines, Dedicated interrupts, Software interrupts	
2		**8086 programming**	03
	2.1	Addressing modes	
	2.2	Instruction Set and Assembler Directives	
3		**8086 Interfacing –Part I**	06
	3.1	Generating the 8086 System Clock and Reset Signals using 8284 clock generator	
	3.2	8086 Minimum and Maximum Mode CPU Modules	
	3.3	Memory interfacing	
4		**The 8051 Microcontroller**	03
	4.1	Differences between a Microprocessor and Microcontroller	
	4.2	Architecture of 8051	
	4.3	Memory Organization of the 8051	
5		**8051 Programming**	09
	5.1	Addressing modes	
	5.2	Instruction set	
	5.3	Assembly language programming.	
	5.4	C Programming	
6		**8051 Interfacing**	12
	6.1	I/O port programming	
	6.2	Programming 8051 Timers	
	6.3	Serial Port Programming	

	6.4	Interrupts Programming	
	6.5	IO Interfacing -LCD & Keypad, ADC, DAC, Stepper and DC Motors	
	6.6	Introduction to 8051 variants Atmega 8 , Nuvoton MS51	
		Total	**39**

Textbooks:	
1	8086/8088 family: Design Programming and Interfacing: By John Uffenbeck (Pearson Education)
2	Microprocessor and Interfacing: By Douglas Hall (TMH Publication)
3	The 8051 Microcontroller and Embedded Systems Using Assembly and C: By M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay, Pearson Education, 2ndEdition.
Reference Books:	
1	Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: By Liu & Gibson (PHI Publication).
2	The 8051 Microcontroller: ByKenneth J. Ayala, Cengage Learning India Pvt. Ltd, 3rdEdition
2	The INTEL Microprocessors, Architecture, Programming and Interfacing: By Barry B. Brey (PearsonPublishers, 8th Edition)
3	Microcontrollers: Architecture, Programming, Interfacing and System Design: By RajKamal, Pearson Education, 2005.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ECC 405	Discrete structures and Automata Theory	3

Course Prerequisites:	
Engineering Mathematics - I, II & III	
Course Objectives:	
1	To cultivate clear thinking for Creative Problem Solving.
2	To train students to understand and construct Mathematical Proofs.
3	To introduce the notions of Sets, Relations, Functions, Graphs and their applications.
4	To build concepts of theoretical design of Basic machines, Deterministic and NonDeterministic Finite state machines and Pushdown Machines.
5	To gain the conceptual understanding of fundamentals of Grammars.
6	To prepare students with the mathematical aspects in other courses such as Formal Specification, Verification, Artificial Intelligence etc
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2	Reason Logically.
3	Perform operations with Sets, Relations, Functions, Graphs and their applications.
4	Design Deterministic Finite Automata (DFA) and Non-deterministic Finite Automata (NFA) and Pushdown Automata with understanding of power and limitations.
5	Design Context Free Grammar and perform the operations like simplification and normal forms.
6	Apply Discrete Structures and Automata Theory concepts into solving real world computing problems in the domain of Formal Specification, Verification, Artificial Intelligence etc

Module No.		Contents	Hrs
1		**Set Theory and Logic**	06
	1.1	Set Theory: Fundamentals - Sets and Subsets, Venn Diagrams, Operations on sets,Laws of Set Theory, Power Set,.	
	1.2	Principle of Inclusion and Exclusion, Mathematical Induction.	
	1.3	Propositions and Logical operations, Truth tables,Equivalence, Implications	
	1.4	Laws of Logic, Normal Forms, Inference	
	1.5	Predicates and Quantifiers	
2		**Relations and Functions**	07
	2.1	Relations- Definition, Properties of Relations	
	2.2	Types of binary relations (Equivalence and partial ordered relations),	
	2.3	Closures, Poset, Hasse diagram and Lattice	
	2.4	Functions-Definition,Types of Functions (Injective, Surjective and Bijective)	
	2.5	Identity and Inverse Functions	
	2.6	Pigeonhole Principle, Extended Pigeonhole Principle	
3		**Graph Theory**	07
	3.1	Graphs and their basic properties - degree, path, cycle, subgraphs, Types of graphs.	
	3.2	Definitions, Paths and circuits: Eulerian and Hamiltonian, Planner Graph.	
	3.3	Isomorphism of graphs, Dijkstra Shortest Path Algorithm	
	3.4	Trees, Types of Trees	
4		**Finite Automata**	07
	4.1	Introduction of Automata and its applications	
	4.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA):Definitions, transition diagrams and Language recognizers, NFA to DFA Conversion.	
	4.3	Eliminating epsilon-transitions from NFA.	
	4.4	FSM with output: Moore and Mealy machines.	
5		**Regular Expression (RE) and Regular Grammar (RG)**	05
	5.1	Regular Grammar and Regular Expression (RE): Definition,Equivalence andConversion from RE to RG and RG to RE.	

	5.2	Equivalence of RE and FA, Converting RE to FA and FA to RE.	
6	**6**	**Context Free Grammar (CFG) and Push Down Automata(PDA)**	07
	6.1	Grammars: Chomsky hierarchy, CFG- Definition, Sentential forms,Leftmost and Rightmost derivations.	
	6.2	Context Free languages (CFL): Parsing and Ambiguity.CFLs: Simplification and Applications.	
	6.3	Normal Forms: Chomsky Normal Form	
	6.4	PDA- Definition, Transitions (Diagrams, Functions and Tables), Design of PDAwith Graphical Notation and Instantaneous Descriptions.	
		Total	**39**

Textbooks:	
1	BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "DiscreteMathematical Structures", Pearson Education.
2	C.L.Liu, "Elements of Discrete Mathematics", Second edition 1985, McGraw-HillBook Company, Reprinted 2000.
3	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages andComputation‖", Pearson Education.
4	Vivek Kulkarni, "Theory of Computation", Oxford University Press, India.
Reference Books:	
1	K.H.Rosen, "Discrete Mathematics and applications", fifth edition 2003, Tata McGraw Hill publishing Company.
2	Y N Singh, "Discrete Mathematical Structures", Wiley-India.
3	J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India
4	J. P. Trembley, R. Manohar "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill.
5	Seymour Lipschutz, Marc Lars Lipson," Discrete Mathematics" Schaum's Outline, McGraw Hill Education.
6	Daniel I. A. Cohen," Introduction to Computer Theory", Wiley Publication.
7	Michael Sipser, "Theory of Computation", Cengage learning.

8	J. C. Martin, “Introduction to Languages and the Theory of Computation”, Tata McGraw Hill.
9	Krishnamurthy E. V., “Introductory Theory of Computer Science”, East-West Press.
10	Kavi Mahesh, “Theory of Computation: A Problem Solving Approach“, Wiley-India.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Electronic Circuits Lab

Lab Code	Lab Name	Credit
ECL 401	**Electronic Circuits Lab**	**1**

Prerequisite: Electronic Devices Laboratory (ECL 302)	
Lab Objectives:	
1	To deliver a hands-on approach for studying electronic circuits using electronic devices.
2	To practically analyze & compute performance parameters of various electronic circuits.
3	To familiarize with principles of designing of practical electronic circuits as per given specifications.
4	To develop an overall approach for students from selection of integrated circuit, specification, functionality and applications.
Lab Outcomes:	
1	Experimentally evaluate performance of amplifiers through frequency response.
2	Analyze differential amplifiers for various performance parameters.
3	Implement practically various applications and circuits based on operational amplifiers.
4	Design an application with the use of integrated circuits as per the given specifications.
5.	Express mathematically the performance parameters in terms of circuit parameters.
6	Choose an appropriate circuit for the given specifications/ applications.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Hardware Experiment Name**
1	To implement a single stage MOSFET CS amplifier and study its frequency response.
2	To implement a Cascode amplifier and study its frequency response.
3	To determine input and output impedance of a CS amplifier with and without feedback.
4	Experiment on op amp parameters.
5	Experiment on design of application using op amp
6	Experiment on applications of opamp-comparator, zero crossing detector.
7	To perform an experiment to study the performance of an RC phase shift oscillator.
8	To perform an experiment to study the performance of Crystal oscillators.
9	Experiment on ADC interfacing
10	Experiment on DAC interfacing

List of Simulation Experiments

Sr. No.	Simulation Experiment Name
1	SPICE simulation of frequency response of single stage CS MOSFET amplifier.
2	SPICE simulation of frequency response of Cascode amplifier.
3	SPICE simulation on op amp parameters.
4	SPICE simulation on design of application using op amp.
5	SPICE simulation of applications of Op Amps -Comparator, Zero crossing detector.
6	SPICE simulation of RC phase shift oscillator.
7	SPICE simulation of Wien Bridge oscillator.
8	SPICE simulation of Crystal oscillator.

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 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)
Continuous assessment exam	
1	Based on the subject and related lab of **ECC 402** and **ECL 401**

Controls and Instrumentation_Lab

Lab Code	Lab Name	Credit
ECL 402	**Controls and Instrumentation Lab**	**1**

Prerequisite:	
Lab Objectives:	
1	To determine the performance of control systems
2	To determine the stability of control systems
3	To understand the applications of instrumentation systems.
Lab Outcomes:	
1	Simulate the performance of control systems
2	Analyze the stability of control systems via simulations
3	Develop the applications of Instrumentation systems
4	Understand the working of sensors and transducers
5.	Understand instrument communication standards
6	Understand the SCADA system

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Experiment Name**
1	Obtain the transient response and time domain parameters for first and second order control systems. (using trainer kits or simulation)
2	Determine step and impulse response for Type ‘0’, Type ‘1’, and Type ‘2’ systems. (Using trainer kits or simulation)
3	Determine root locus plot for second order system using simulation (MATLAB/ Scilab) and obtain controller domain specification parameters. (verify results theoretically)
4	Determine Bode plot using MATLAB/Scilab for second order control system and obtain frequency domain specification parameters. (verify results theoretically)
5	Analyze the effect of PI and PD controller on system performance (using trainer kits/MATLAB/Scilab)
6	Displacement measurement using LVDT.
7	Temperature measurement using thermistor, thermocouple and RTD.
8	Displacement measurement using capacitive transducer.
9	Pressure Measurement using Strain Gauge
10	Modification of Single channel DAS to Multichannel DAS
11	Demonstration of the SCADA system using open Source software
12	Design of 4-20 mA current loop
13	Use of any Industrial interface/BUS for effective communication.

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 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)
Continuous assessment exam	
1	Based on the subject and related lab of **ECC 403** and **ECL 402**

Lab Code	Lab Name	Credit
ECL 403	**Microprocessors and Microcontrollers Lab**	**1**

Prerequisite:	
Lab Objectives:	
1	To write Assembly language programs for Microprocessors and Microcontrollers for various applications.
2	To know the importance of different peripheral devices and their interfacing to 8086 and 8051
Lab Outcomes:	
1	To develop programming skills for Microprocessors and Microcontrollers
2	To interface various devices in Microprocessor and Microcontroller systems

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Experiment Name
1	Arithmetic Operations, Logical operations (using 8086)
2	Data Transfer, Arithmetic, Logical operations using 8051
3	Use of Subroutine in 8051 Programming
4	IO Port Programming using 8051
5	Interfacing of led, switch with 8051
6	Serial port programming of 8051

7	Applications of Timers of 8051
8	LCD Interfacing (using 8051)
9	Sensor interfacing using an ADC (using 8051)
10	Generation of different waveforms using DAC (using 8051)
11	Interfacing of Keypad with 8051
12	Interfacing of DC, Stepper , servo motors with 8051.

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 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)
Continuous assessment exam	
1	Based on the subject and related lab of **ECC 404** and **ECL 403**

Course Code	Lab Name	Credit
ECL 404	**Skill- Based Lab :Python Programming**	**1**

Prerequisite: ECL 304 – Skill Lab: C++ and Java Programming	
Course Objectives:	
1	Describe the core syntax and semantics of Python programming language.
2	Explore file handling in Python
3	Infer the Object-oriented Programming concepts in Python
4	Formulate GUI Programming and Databases operations in Python
5	Develop applications using variety of libraries and functions
Course Outcomes:	
1	Describe syntax and semantics in Python
2	Illustrate different file handling operations
3	Interpret object-oriented programming in Python
4	Design GUI Applications in Python
5	Express proficiency in the handling Python libraries for data science
6	Develop machine learning applications using Python.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Python**	06
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python.	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties,Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements.	
2		Functions and File I/O Handling	06
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, with keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3		**Object Oriented Programming**	08
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4		**Graphical User Interface and Image processing**	08
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6		**Python Applications**	10
	6.1	GUI based applications	

	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor	
	6.5	Support Vector Machines	

Textbooks:	
1	YashvantKanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1st edition (8 July 2019)..
2	Dusty Phillips, “Python 3 object-oriented Programming”, Second Edition PACKT Publisher, August 2015.
3	John Grayson, “Python and Tkinter Programming”, Manning Publications (1 March 1999).
4	Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5	Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6	Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education
Reference Books:	
1	Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1st edition (8 December 2015).
2	Paul Barry, “Head First Python” O′Reilly; 2nd edition (16 December 2016)
3	Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly
4	Beautiful World of Computers and Code”, Addison Wesley; 3rd edition (1 October 2013).
5	Andreas C. Mueller, “Introduction to Machine Learning with Python”, O’Reilly; 1st edition (7 October 2016)
6	David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3rd edition (10 May 2013)
7	Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI

8	Programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

Python IDE: https://www.python.org/downloads/

Anaconda Environnent: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

Sr. No.	Problem Statement	ModuleNo.
1	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). 5. Write a program to convert and print this distance in meters, feet, inches and centimeter. 6. Write a program to carry out the following operations on the given set 7. s = {10, 2, -3, 4, 5, 88} a) Number of items in sets s b) Maximum element in sets s c) Minimum element in sets s d) Sum of all elements in sets s e) Obtain a new sorted set from s, set s remaining unchanged f) Report whether 100 is an element of sets s g) Report whether -3 is not an element of sets s.	**Module 1**

2	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. 3. Generate and print a list of tuples containing name, age and salary from the 3 lists. From thislist generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	**Module 2**
3	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	**Module 3**
4	1. Write Python program to create, append, update, delete records from database usingGUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtaina. individual histograms. 4. Write Python program for histogram equalization5. Write Python Program for edge detection 5. Write Python Program for image segmentation 6. Write Python program to implement GUI Canvas application using Tkinter 7. Write Python program to implement GUI Frame application using Tkinter	

5	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames. 3. Evaluate the dataset containing the GDPs of different countries to: a) Find and print the name of the country with the highest GDP b) Find and print the name of the country with the lowest GDP c) Print text and input values iteratively d) Print the entire list of the countries with their GDPs e) Print the highest GDP value, lowest GDP value, mean GDPvalue, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a) View: aircraft make name, state name, aircraft model name, text information,flight phase, event description type, fatal flag b) Clean the dataset and replace the fatal flag NaN with “No”. c) Find the aircraft types and their occurrences in the dataset d) Remove all the observations where aircraft names are not available e) Display the observations where fatal flag is “Yes” 5. Analyze the “auto mpg data” and draw a pair plot using seaborn library for mpg, weight,and origin. (a) Origin: This dataset was taken from the StatLib library maintained at CarnegieMellon University.· ● Number of Instances: 398 ● Number of Attributes: 9 including the class attribute ● Attribute Information: ● mpg: continuous· cylinders: multi-valued discrete ● displacement: continuous ● horsepower: continuous ● weight: continuous ● acceleration: continuous ● model year: multi-valued discrete ● origin: multi-valued discrete ● car name: string (unique for each instance) 6. Write a python program to use SciPy to solve a linear algebra problem.	

	7. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each.Find the number of true or false and multiple-choice questions	
6	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server	

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

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.

Term Work:

At least 12 experiments and 1 course project should be performed. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Mini Project - 1B

Course Code:	Course Title	Credit
ECM 401	Mini Project - 1 B	2

Course Prerequisites:	
Course Objectives:	
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:	
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 life-long learning.
9	Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini 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 mini 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 Institute.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first 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.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students’ group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
        - First shall be for finalization of problem and proposed solution
        - Second shall be for implementation and testing of solution.

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of the solution. (Innovative/out of box solution)

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey
a) Survey of Existing system
b) Limitations of Existing system or research gap
c) Problem Statement and Objective
d) Scope

iv. Proposed System
a) Analysis/Framework/ Algorithm
b) Details of Hardware & Software
c) Design details
d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Along with the project report a folders of project documentation, all literature survey papers, implemented code, required software, utilities, used component details, user manual etc, is to be submitted.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

13. Quality of survey/ need identification
14. Clarity of Problem definition based on need.
15. Innovativeness in solutions

16. Feasibility of proposed problem solutions and selection of best solution
17. Innovativeness and out of box thinking
18. Cost effectiveness and Societal impact
19. Functional working model as per stated requirements
20. Effective use of skillsets acquired through curriculum including DLOs
21. Effective use of standard engineering practices & norms
22. Contribution of an individual as team member/Leader
23. Feasibility to deploy the solution on large scale
24. Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria’s and remaining may be used for second semester evaluation of performance of students in mini- project.

In case of half year project all criteria’s in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

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

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity

Innovativeness in solutions
Cost effectiveness and Societal impact
Implementation of working model
Effective use of diversified skill-set
Effective use of standard engineering practices & norms
Contribution of an individuals as a member/Leader
Clarity in written and oral communication

Department of Electronics Engineering

Academic Year 2023-24

Semester V, VI, VII and VIII

Program Structure for Third Year Electronics Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Practical	Theory	Practical	Tutorial	Total
ELC501	Principles of Control System	3	-	3	-	-	3
ELC502	Digital Signal Processing	3	-	3	-	-	3
ELC503	Linear Integrated Circuits	3	-	3	-	-	3
ELC504	Digital Communication	3	-	3	-	-	3
ELDO501	Department Optional Course - I	3	-	3	-	-	3
ELL501	Principles of Control System Lab	-	2	-	1	-	1
ELL502	Linear Integrated Circuits Lab	-	2	-	1	-	1
ELL503	Digital Communication Lab	-	2	-	1	-	1
ELL504	Professional Communication & Ethics-II	-	2* + 2	-	2	-	2
ELM501	Mini Project–2 A	-	4 $	-	2	-	2
	Total	15	14	15	07	-	22

* Theory class ; $ indicates workload of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ELC501	Principles of Control System	20	20	60	2	25	-	125
ELC502	Digital Signal Processing	20	20	60	2	-	-	100
ELC503	Linear Integrated Circuits	20	20	60	2	-	-	100
ELC504	Digital Communication	20	20	60	2	-	-	100
ELDO501	Department Optional Course - I	20	20	60	2	-	-	100
ELL501	Principles of Control System Lab	-	-	-	-	25	25	50
ELL502	Linear Integrated Circuits Lab	-	-	-	-	25	25	50
ELL503	Digital Communication Lab	-	-	-	-	25	25	50
ELL504	Professional Communication & Ethics-II	-	-	-	-	25	25	50
ELM501	Mini Project–2 A	-	-	-	-	25	25	50
	Total	100	100	300	-	125	125	750

1. Data Structures	3. Neural Network and Fuzzy Logic
2. Biomedical Instrumentation	4. Computer Organization Architecture

Course Code	Course Title	Credit
ELC 501	Principles of Control System	03

Prerequisite:	
1	Applied Mathematics
Course Objectives:	
1	To develop the understanding of fundamental principles of control systems.
2	To disseminate the basic methods for time-domain and frequency-domain analysis of control systems.
3	To develop the concept of stability and its assessment for linear-time-invariant systems.
4	To introduce the design of controllers in frequency-domain and state-space.
Course Outcomes: After successful completion of the course students will be able to:	
1	Derive the mathematical models of physical systems.
2	Sketch various plots in time and frequency domain and analyse the system using the plots.
3	Evaluate the stability of control systems in time and frequency domain.
4	Design performance specification based controller for a given system.
5	Analyse the control systems using state-space methods and design state feedback controllers.
6	Design performance specification based controller for a given system.

Module No.		Contents	Hrs.
1		**Introduction to the Control Problem**	06
	1.1	Introduction to the control problem; open loop and closed loop systems; feed-forward control structure.	
	1.2	Differential equation models of physical systems, deriving models of physical systems (electrical, mechanical, thermal) Types of models; Impulse response model; Transfer function model for physical systems.	
	1.3	Block diagram and Signal Flow Graph (SFG) representation of control systems; Block diagram reductions; Mason's gain formula.	
2		**Time response analysis and stability analysis in time domain**	**06**
	2.1	Standard test input signals; time response of first and second order systems for standard test inputs; Application of initial and final value theorem. Performance specifications for second order system (no derivation); Error constants and type of the system.	
	2.2	Concept of stability; Routh-Hurwitz Criteria; Relative stability analysis; Root-Locus technique and construction of root-loci.	
3		**Frequency Response Analysis**	**08**
	3.1	Introduction to frequency response; Frequency response plots: Polar plot and Bode plot; Performance specifications in frequency domain.	
	3.2	Stability margins in frequency domain; The Nyquist criterion; Relative stability using Nyquist criterion.	
4		**Introduction to Controller Design**	**10**
	4.1	Characteristics of feedback: Sensitivity to parametric variation; Disturbance rejection; Steady-state accuracy.	
	4.2	Feedback controller design using Root-locus;	
	4.3	Feedback control design using Bode plot;	
5		**State-space Analysis**	**07**
	5.1	Concept of state variables; State-space model; Canonical forms;	
	5.2	Solution of state-space equation; Eigen-values and eigenvectors; Stability in state-space; Concept of controllability and observability.	

6		**Controller Design in State-space**	**02**
	6.1	State-feedback controller design: Pole-placement method; Ackerman's formula.	
		Total	**39**

Textbooks:	
1	M. Gopal, "Control Systems: Principles and Design", 3rd edition, Tata McGraw Hill, 2008.
2	Richard Dorf, Robert Bishop, "Modern Control Systems", 11th edition, Pearson Education, 2008.
Reference Books:	
1	Golnaraghi Farid, B. C. Kuo, "Automatic Control Systems", 10th edition, McGraw Hill, 2017.
2	K. Ogata, "Modern Control Engineering", 6th edition, Prentice Hall, 2010.
3	I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 2009.
4	Norman Nise, "Control Systems Engineering", Wiley, 8th edition, 2019.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
ELC 502	**Digital Signal Processing**	03

Prerequisite:	
1	ELC405: Signals and Systems
Course Objectives:	
1	To introduce Fourier domain analysis of signals and systems and their efficient implementation.
2	To expose students to various design techniques for FIR/IIR filters.
3	To unveil the students to advances in signal processing techniques, digital signal processors and real-world applications
Course Outcomes: After successful completion of the course students will be able to:	
1	Analyze discrete time systems in frequency domain using Discrete Fourier Transform.
2	Design IIR digital filters to meet given filter specifications and implement the same using lattice structure.
3	Design FIR digital filters to meet given filter specifications and implement the same using lattice structure.
4	Understand Architecture of DSP processors and examine the effect of hardware limitations on performance of digital filters.
5	Investigate the need of multi-rate digital signal processing and implement multi-rate systems.
6	Apply DSP techniques in real life problems.

Module		Content	Hrs
1		**Discrete Fourier Transform and Fast Fourier Transform**	**10**
	1.1	Definition and Properties of DFT, IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT, Filtering of long data sequences using Overlap Save and Overlap Add Method	
	1.2	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	
2		**Design of Infinite Impulse Response (IIR) Filters**	**8**
	2.1	Analog filter approximations: Butterworth, Chebyshev, Inverse Chebyshev and Elliptic filters	
	2.2	Mapping of S-plane to Z-plane, Impulse invariance method, Bilinear transformation method, Design of IIR digital filters from analog filters with examples (Butterworth, Chebyshev)	
	2.3	Realization of IIR filters using Lattice structures	
3		**Design of Finite Impulse Response(FIR) Filters**	
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters, Frequency response and location of zeros for linear phase FIR filters	**7**
	3.2	Effect of truncation on ideal filter impulse response, Design of FIR filters using window techniques (Rectangular, Hamming, Hanning), Design of FIR filters using Frequency Sampling Technique	
	3.3	Realization of FIR filters using Lattice structure	
4		**DSP Processors and Finite Word Length Effects**	**7**
	4.1	Introduction to General Purpose and Special Purpose DSP processors, Fixed point and floating-point DSP processors, Architecture of TMS320CXX processor	
	4.2	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Coefficient quantization error, Limit cycle oscillations, Finite word length effects in FIR/IIR digital filters	
5		**Multirate DSP and Filter Banks**	**4**

	5.1	Introduction and concept of Multirate Processing, Decimator and Interpolator, Decimation and Interpolation by Integer numbers	
	5.2	Multistage Approach to Sampling rate converters,Sample rate conversion using Polyphase filter structure	
6		**Multirate DSP and Filter Banks**	**3**
	6.1	Application of DSP in Radar Signal Processing	
	6.2	Application of DSP in Speech Signal Processing: Echo cancellation	
	6.3	Application of DSP in Biomedical Signal Processing: Denoising of ECG Signal	
		Total	**39**

Textbooks:	
1	Proakis J., Manolakis D., “Digital Signal Processing”, 4th Edition, Pearson Education, 2007
2	Tarun Kumar Rawat, “Digital Signal Processing”, Oxford University Press, 2015
Reference Books:	
1	L .R. Rabiner and B. Gold, “Theory and Applications of Digital Signal Processing”, Prentice-Hall of India, 2006.
2	Oppenheim A., Schafer R., Buck J., “Discrete Time Signal Processing”, 2nd Edition, Pearson Education
3	Johnson J. R., “Introduction to Digital Signal Processing”, Prentice Hall
4	Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education, 2001
5	Sanjit K. Mitra, Digital Signal Processing – A Computer Based Approach – edition 4e McGraw Hill Education (India) Private Limited
6	B. Venkata Ramani and M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, Tata McGraw Hill, 2011.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
ELC 503	**Linear Integrated Circuits**	**03**

Prerequisite:	
1.	Electronic Devices and Circuits I
2.	Electronic Devices and Circuits II
Course Objectives:	
1.	To teach fundamental principles of standard linear integrated circuits.
2.	To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Demonstrate an understanding of fundamentals of integrated circuits.
2	Analyze the various applications and circuits based on particular linear integrated circuit.
3	Select and use an appropriate integrated circuit to build a given application.
4	Design an application with the use of integrated circuit.
5	Design a real-life application using certain linear Integrated Circuits.
6	Design of power supply with proper selection of the regulator IC.

Module No.		Contents	Hrs.
1		**Fundamentals of Operational Amplifier**	
	1.1	Block diagram of op-amp, Characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, single supply versus dual supply op-amp	**04**
	1.2	Configurations of op-amp: - open loop and closed loop configuration, Inverting amplifier and non-inverting amplifier	
2		**Linear Applications of Operational Amplifier**	
	2.1	Adder, Subtractor, Difference amplifier, Integrator, Differentiator, Three Op-amp Instrumentation amplifier, V-I converter, I-V converter	**08**
	2.2	Active Filters: - Transfer function, Design of First order and Second order of LPF, HPF, BPF and BRF	
	2.3	Oscillators: - RC phase shift and Wein bridge oscillators with its derivation and design numerical.	
3		**Non-linear Applications of Operational Amplifier**	
	3.1	Voltage Comparators, Applications of comparator as zero crossing detector, window comparator, level detector, Schmitt triggers, Half wave and full wave rectifiers, Peak detectors, Sample & Hold circuit, Log and Antilog amplifier.	**08**
	3.2	Waveform generators: - Square wave and Triangular wane generator circuit with its derivation and design numerical.	
4		**Data Converters**	
	4.1	Analog to Digital: - Performance parameters, working of Simple ramp, Dual slop, Successive approximation and Flash ADC. *(No numerical expected)*	**06**
	4.2	Digital to Analog: - Performance parameters, working of Binary weighted and R/2R ladder. *(No numerical expected)*	
5		**Special Purpose Integrated Circuits**	
	5.1	Monolithic Timer: NE555: - functional block diagram, working, design and applications.	**07**

	5.2	Voltage controlled oscillator 566 and PLL 565: - Functional block diagram, working and design.	
6		**Voltage Regulators**	
	6.1	Functional block diagram of Voltage Regulators, Design of fixed voltage Regulators (78XX and 79XX), three terminal adjustable voltage regulators (LM 317 and LM 337)	**06**
	6.2	Functional block diagram, working and design of IC 723 for LVLC and LVHC applications.	
		Total	**39**

Textbooks:	
1	Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Tata McGraw Hill, 3rd Edition.
2	D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.
3	Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4 th Edition.
Reference Books:	
1	William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson, 4th Edition.
2	David A. Bell, "Operation Amplifiers and Linear Integrated Circuits", Oxford University Press, Indian Edition.
3	Ron Mancini, "Op Amps for Everyone", Newnes, 2nd Edition.
4	J. Millman and A. Grabel, "Microelectronics", Tata McGraw Hill, 2nd Edition
5	R. F. Coughlin and F. F. Driscoll, "Operation Amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition.
6	J. G. Graeme, G. E. Tobey and L. P. Huelsman, "Operational Amplifiers- Design & Applications", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code	Course Title	Credit
ELC 504	**Digital Communication**	**03**

Prerequisites:	
• ELX404 Principles of Communication Engineering • ELX405 Signals & Systems.	
Course Objectives:	
1	Understand the typical subsystems of a digital communication system.
2	Understand the significance of the trade-off between SNR and Bandwidth.
3	Understand the effect of ISI in Baseband transmission of a digital signal.
4	Analyze various Digital modulation techniques.
5	Identify the necessity of Source encoding and Channel encoding in Digital Communication.
Course Outcomes: After successful completion of the course students will be able to:	
1	Comprehend the advantages of digital communication over analog communication and explain the need for various subsystems in Digital communication systems.
2	Realize the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3	Understand the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect.
4	Analyze various Digital modulation methods and assess them based on parameters such as spectral efficiency, Power efficiency, Probability of error in detection.
5	Explain the concept and need for designing efficient Forward Error Correcting codes.
6	Understand the Optimum reception of Digital signals.

Module No.		Contents	Hrs.
1		**Introduction to Digital communication system and Probability Theory**	7
	1.1	Introduction to Digital communication system, significance of AWGN Channel, pulse dispersion in the channel.	
	1.2	Concept of Probability Theory in Communication Systems: Introduction to probability and sample space, Bayes' rule, conditional probability and statistical independence, relation between probability and probability density, PDF, CDF, Random variables, Mean and Variance of Random variables and sum of random variables, Definition with examples	
	1.3	Gaussian, Rayleigh PDF & Rician Distribution, Binomial Distribution, Poisson Distribution, Central-Limit Theorem.	
2		**Information Theory and Source Coding**	5
	2.1	Measure of Information, Entropy, Information rate, Channel capacity, Shannon – 05 Hartley Capacity Theorem and its Implications.	
	2.2	Shannon-Fano encoding, Huffman encoding, Code Efficiency and Redundancy examples and applications of source coding.	
3		**Pulse Shaping for Optimum Transmission**	4
	3.1	Line codes and their desirable properties.	
	3.2	Baseband PAM transmission: Concept of Inter symbol interference (ISI), Raised Cosine filter, Nyquist Bandwidth. Concept of equalizer to overcome ISI.	
4		**Digital Modulation Techniques**	10
	4.1	Concept of Binary and M-ary transmission, Coherent and Non- Coherent reception, 10 Power spectral density of Pass-band signal, Signal space Representation and Euclidean distance.	
	4.2	Pass Band Amplitude modulation and Demodulation: BASK, M-ary PAM, Digital Phase Modulation & Demodulation: BPSK, OQPSK, QPSK, M-ary PSK, QAM, Digital Frequency Modulation and Demodulation: BFSK, MSK, M-ary FSK, Introduction to spread spectrum modulation, OFDM.	
5		**Error Control codes**	9
	5.1	Need for channel encoding, Concept of Error detection and correction, Forward Error correction.	
	5.2	Linear block codes: Hamming Distance, Hamming Weight, Systematic codes, Syndrome Testing.	

	5.3	Cyclic codes; Generator polynomial for Cyclic codes, Systematic cyclic codes, Feedback shift register for Polynomial division.	
	5.4	Convolution codes: Convolution encoder, Impulse response of encoder, State diagram, trellis diagram Representations.	
6		**Optimum Reception of Digital Signal**	**4**
	6.1	A baseband signal receiver and its Probability of error.	
	6.2	The Optimum receiver and Filter.	
		Total	**39**

Text Books:	
1	Haykin Simon, “Digital Communication Systems,” John Wiley and Sons, New Delhi, Fourth Edition, 2014.
2	H. Taub, D. Schilling, and G. Saha, “Principles of Communication Systems,” Tata McGraw Hill, New Delhi, Third Edition, 2012
3	Lathi B P, and Ding Z., “Modern Digital and Analog Communication Systems,” Oxford University Press, Fourth Edition, 2009
4	R N Mutagi, “Digital Communication”, Oxford University Press, 2nd Ed

Reference Books:	
1	John G. Proakis, “Digital Communications”, McGraw Hill , 5th Ed
2	Sklar B, and Ray P. K., “Digital Communication: Fundamentals and applications,”Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
3	T L Singal, “Analog and Digital Communication,” Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
4	P Ramakrishna Rao, “Digital Communication,” Tata Mc-Graw Hill, New Delhi, First Edition, 2011
5	Amitabha Bhattacharya, “Digital Communication”, Tata McGraw Hill.

Internal Assessment:
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Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
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4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELDO5011	**Data Structures**	**3**

Prerequisite:	
• Knowledge of one or more programming language e.g. C, C++. JAVA, Python and proficiency in any one of them.	
Course Objectives:	
1	To understand basic linear and non-linear data structures.
2	To implement various operations on Arrays, linked list, stack, queue, binary tree, and graph.
3	To study different sorting and searching techniques.
4	To analyze efficient data structures to solve real world problems
Course Outcomes:	
1	Understand various linear data structures.
2	Perform operations on linear data structures.
3	Comprehend various nonlinear data structures.
4	Implement various operations on nonlinear data structures.
5	Analyze appropriate sorting and searching techniques for a given problem.
6	Apply appropriate data structure and algorithms for solving real world problems.

Module No.	Contents	Hrs
1	**Introduction to Data Structures**	04
	Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array, Static arrays vs Dynamic Arrays, structures.	
2	**Stack and Queues**	08
	Introduction, Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue, Representation of a Queue using array, Circular Queue, concept of priority Queue, Applications of Queue-Round Robin Algorithm.	
3	**Linked List**	08
	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List (SLL), Operations on Singly Linked List : Insertion , Deletion ,reversal of SLL, Print SLL . Implementation of Stack and Queue using Singly Linked List. Introduction to Doubly Linked List and Circular Linked List	
4	**Trees**	07
	Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree – Expression Tree, Huffman Encoding, AVL tree	
5	**Graphs**	05
	Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting. Architecture Patterns of NoSQL, Key-Value Store Database, Column Store Database, Document Database, Graph Database	
6	**Introduction to Sorting and Searching**	07

	Introduction to Searching: Linear search, Binary search Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort, ,Greedy Algorithms, Dynamic Programming Algorithms and complexity analysis, Comparison of sorting Techniques, Hashing Techniques, Different Hash functions, Collision & Collision resolution techniques: Linear and Quadratic probing, Double hashing.	
	Total	39

Textbooks:	
1	Tenenbaum, A. M., “Data structures using C”, Pearson Education India, 1990.
2	Tremblay, J. P., & Sorenson, P. G., “An introduction to data structures with applications”, McGraw-Hill, Inc, 1984.
3	Thareja, R., “Data structures using C”, Oxford University Pres, 2014.
4	Gilberg, R. F., Forouzan, B. A., “Data Structures”, United States, Cengage Learning, 2004.
5	Balagurusamy, E., “Data Structures Using C”, McGraw-Hill Education (India), 2013.
Reference Books:	
1	Bhasin, H., “Algorithms: Design and Analysis”, Oxford University Press, 2015.
2	DATA STRUCTURES USING C, 2E. Tata McGraw-Hill Education, 2006.
3	Rajasekaran, S., Sahni, S., Horowitz, E., “Computer Algorithms”, United States, Silicon Press, 2008.
4	Lipschutz, S., “Data Structures”, McGraw Hill Education (India) Private Limited. Schaum’s Outlines, 2014.

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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO5012	**Biomedical Instrumentation**	**3**

Prerequisite:	
● Knowledge of Instrumentation and Measurement ● Display devices and measurement tools ● Knowledge of Human anatomy	
Course Objectives:	
1	To introduce the fundamentals of Biomedical Instrumentation Systems
2	To explore the human body parameter measurement setups
3	To make the students understand the basic concepts of diagnostic, therapeutic and imaging systems.
Course Outcomes: After successful completion of the course students will be able to:	
1	Get basic technical competence in the field of Medical Instrumentation and understand the importance of electrical safety in hospital equipment
2	Explain the concept of bio potential generation and measurement using electrodes with their types.
3	Build foundation of knowledge of analytical Instruments in Biomedical field
4	Acquire knowledge about the Diagnostic Equipment like ECG, EEG, EMG machines
5	Describe the working principle of patient monitoring and assistive systems
6	Distinguish between various imaging modalities such as X-ray, CT, MRI etc. based on their principles.

Module		Content	Hrs
1		**Fundamentals of Biomedical Instrumentation:**	6
	1.1	Basics of Medical Instrumentation, Recording Systems & Biomedical Recorders, Types of biomedical equipment – Analytical, Diagnostic, Therapeutic and Surgical equipment	
	1.2	Calibration of medical devices and testing of biomedical equipment, Electrical classification of Biomedical Equipment Patient Monitoring Systems, Patient safety	
2		**Measurement of bio potentials**	6
	2.1	Basics of Cardiovascular and Nervous systems, Bio-potential generation, Electrodes for ECG, EEG, EMG	
	2.2	Electrode-tissue interfaces, electrode-electrolyte and electrolyte-skin interfaces, Skin contact impedance	
3		**Analytic Instruments**	6
	3.1	Principle and working of - Pulse Oximeter, Plethysmographs, Blood Flow Meters	
	3.2	Introduction to Spectro photometers, Electrodes for pH, pO2 and pCO2 measurement, Blood gas analysers –, Blood cell counters, Radio Immuno Assay and ELISA techniques	
4		**Diagnostic Equipment**	7
	4.1	Electrocardiography (ECG) –ECG in diagnosis –Lead systems – Artifacts – ECG Machine. Heart sounds – Phonocardiography (PCG)	
	4.2	Electro encephalography (EEG), EEG Machine, Artifacts, Electromyography (EMG)–Electro neurography (ENG), Principles and applications	
5		**Patient monitoring and Assistive system**	7
	5.1	Bed-side monitors, Central station monitors, Computerized arrhythmia monitors	
	5.2	Cardiac Pacemakers, Defibrillators, Ventilators	
6		**Imaging Equipment**	7
	6.1	Construction and working of X ray, CT, MRI imaging	
	6.2	Basic working principle of PET, SPECT, Ultrasound imaging	
		Total	**39**

Textbooks:	
1	R S. Khandpur, “Handbook of Biomedical Instrumentation”, 2004 (TMH Pub)
2	Leslie Cromwell, “Biomedical Instrumentation and Measurements‖”, Pearson Education, 1980.
3	J G. Webster, “Medical Instrumentation, Application and Design”, (John Wiley).
Reference Books:	
1	Carr –Brown “Introduction to Biomedical Equipment Technology”,(PHI Pub)
2	L. A. Geddes & L. E. Baker, “Principles of Applied Biomedical Instrumentation”, Wiley India Pvt. Ltd
3	Richard Aston, “Principles of Biomedical Instrumentation and Measurements”, Merril Publishing Co.
4	Chanderlekha Goswami, “Handbook of Biomedical Instrumentation”, Manglam Publications

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

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Course Code:	Course Title	Credit
ELDO5013	**Neural Network and Fuzzy Logic**	**3**

Prerequisite:	
● Knowledge of linear algebra, multivariate calculus, and probability theory	
● Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended)	
Course Objectives:	
1	To study basics of biological Neural Network.
2	To understand the different types of Artificial Neural Networks.
3	To identify the applications of ANN.
4	To study fuzzy logic and fuzzy systems
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand learning rules of ANN.
2	Apply the concepts of supervised and unsupervised neural networks
3	Explain the importance of feedback networks.
4	Understand Associative memory networks
5	Appreciate the need for fuzzy logic and control.
6	Illustrate neural networks practical applications

Module		Content	Hrs
1		**Introduction**	**5**
	1.1	Biological neurons, McCulloch -Pitts neuron model, Types of activation function, Network architectures, Knowledge representation. Linear & non-linear separable classes & Pattern classes.	
	1.2	Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning	
	1.3	Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All Learning Rule.	
	1.4	Applications and scope of Neural Networks.	
2		**Supervised Learning Networks**	**8**
	2.1	Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent and least mean square algorithm.	
	2.2	Back Propagation Network.	
	2.3	Radial Basis Function Network.	
3		**Unsupervised Learning Networks**	**8**
	3.1	Fixed weights competitive nets.	
	3.2	Kohonen Self-organizing Feature Maps, Learning Vector Quantization	
	3.3	Adaptive Resonance Theory – 1.	
4		**Associative Memory Networks**	**6**
	4.1	Introduction, Training algorithms for Pattern Association	
	4.2	Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory.	
	4.3	Discrete Hopfield Networks.	
5		**Fuzzy Logic**	
	5.1	Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence	

	5.2	Fuzzification and Defuzzification	**8**
	5.3	Fuzzy Controllers	
6		**Fuzzy Controllers**	**4**
	6.1	• Handwritten Digit Recognition • Process Identification • Air traffic control • Appraisal and valuation of property, buildings, automobiles and machinery • Data mining, cleaning and validation • Employee hiring • Fraud detection regarding credit cards, insurance or taxes, Medical diagnosis	
		Total	**39**

Textbooks:	
1	Jacek M. Zurada, “Introduction to Artificial Neural Systems,” Jaico Publishing House.
2	Timothy J. Ross, “Fuzzy Logic with Engineering Applications,” 3rd edition, Wiley India.
3	S. N. Sivanandam and S. N. Deepa, “Principles of Soft Computing,” 3rd edition,Wiley India.
Reference Books:	
1	Simon Haykin, “Neural Networks A Comprehensive Foundation”, 3rd edition Pearson Education.
2	S Rajasekaran and G A Vijayalakshmi Pai, “Neural Networks and Fuzzy Logic and Genetic Algorithms “, PHI Learning.

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6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO5014	**Computer Organization and Architecture**	**3**

Prerequisite:	
• Digital Electronics • Fundamental concepts of processing	
Course Objectives:	
1	To introduce the learner to the design aspects this can lead to maximized performance of a Computer.
2	To introduce the learner to various concepts related to Parallel Processing
3	To highlight the various architectural enhancements in modern processors.
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Define the performance metrics of a Computer
2	Distinguish between CISC and RISC Design Philosophies
3	Explain the design considerations of Processor, Memory and I/O in Computer systems
4	Analyze the advantages and limitations of Parallelism in systems
5	Apply the principles of pipelining to improve performance
6	Evaluate the various architectural enhancements in modern processors

Module No.		Contents	Hrs.
1		**Introduction to Computer Organization**	**6**
	1.1	Fundamental Units of a Computer and system bus.	
	1.2	Number Representation methods- Integer and Floating-point, Booth's Multiplier, Restoring and Non-Restoring Division	
	1.3	Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops, Amdahl's law	
2		**Processor Organization and Architecture**	**7**
	2.1	Evolution of Intel X86 Architecture, CPU Organization, Register Organization, Instruction cycle, Instruction Formats, Addressing Modes	
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions	
	2.3	Comparison between CISC and RISC architectures	
3		**Memory Organization**	**10**
	3.1	Classification of Memories-Primary and Secondary Memories, RAM, SRAM and DRAM and ROM, EPROM, EEPROM, Memory Inter- leaving	
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency	
	3.3	Virtual Memory Management-Concept, Segmentation, Paging, Page Replacement policies	
4		**Input/Output Organization**	**04**
	4.1	Types of I/O devices and Access methods, Types of Buses, Bus Arbitration	
	4.2	Direct Memory Access (DMA)	
5		**Parallelism**	**07**
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, MESI Protocol	
	5.2	Pipelining - Concept, Speedup, Efficiency, Throughput, Types of Pipeline hazards and solutions	

6		**Architectural Enhancements**	
	6.1	Superscalar Architectures, Out-of-Order Execution, Multi-core processors,Clusters, GPU	**5**
		Total	**39**

Textbooks:	
1	William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.
2	C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.
Reference Books:	
1	J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.
2	B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.
3	D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998.

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8.	Multiple Choice Questions (Quiz)	5 marks

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Lab Code:	Lab Name	Credit
ELL 501	**Principles of Control system LAB**	**1**

Prerequisite:	
1	Applied Mathematics
Lab Objectives:	
1	To develop the understanding of fundamental principles of control systems.
2	To disseminate the basic methods for time-domain and frequency-domain analysis of control systems.
3	To develop the concept of stability and its assessment for linear-time-invariant systems.
4	To introduce the design of controllers in frequency-domain and state-space.
Lab Outcomes: Student will be able	
1	Analyse a control system in time and frequency domain.
2	Design a performance specification based controller in time and frequency domain.
3	Develop and tune PID controller for given control system.
4	Evaluate controllability and observability of a control system.
5.	Design a state feedback controller according to given specifications.

Suggested Experiments: (Expected percentage of H/w and software experiments should be 60% & 40% respectively)	
Sr. No.	**Experiment Title**
1	To study the time response of a first-order and second-order system to standard input signals.
2	To study the frequency response of a second-order system to standard input signals.
3	To solve a differential equation model using simulation software.
4	To study the steady-state errors for type-0, 1 and 2 systems.
5	To design a controller according to given performance specifications using root-locus.
6	To design a controller according to given performance specifications using bode plot.
7	To design appropriate lag, lead or lag-lead compensator using bode plot.
8	To perform stability analysis of several control systems using Nyquist plots.
9	To study controllability and observability of control systems.
10	To design a state feedback controller using pole-placement and ackerman's formula.
11	To introduce the PID controller and its tuning.

(Experiments can be performed online using simulation software as well as hardware. Free simulation software like Scilab 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] and [2].

Term Work:	
1	At least 10 experiments covering the entire syllabus of ELL501 (Principles of Control System) should be set to have well predefined inference and conclusion.
2	The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting.
3	Simulation experiments are also encouraged. Experiments must be graded from time to time.
4	The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged..
5	The grading and term work assessment should be done based on this scheme.
6	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.
Continuous assessment exam	
1	Based on the subject and related lab of **ELL501 & ELC501**

Lab Code:	Lab Name	Credit
ELL 502	Linear Integrated Circuits Lab	1

Prerequisite:	
1	Electronic Devices and Circuits I and II
Lab Objectives:	
1	To teach fundamental principles of standard linear integrated circuits.
2	To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications
Lab Outcomes: Student will be able	
1	Demonstrate an understanding of fundamentals of integrated circuits.
2	Analyze the various applications and circuits based on particular linear integrated circuit.
3	Select and use an appropriate integrated circuit to build a given application.
4	Design an application with the use of integrated circuit
5.	Demonstrate use of ADC and DAC to sense and control physical quantities
6.	Design the Power supply for the given specifications.

Term Work:

At least eight experiments based on the entire syllabus of Subject (Linear Integrated Circuits) should be set to have well predefined inference and conclusion. Few computation/simulation-based experiments are encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment 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

(Expected percentage of hardware and software experiments should be 60% & 40% respectively)

Sr. No.	Experiment Name
1	Experiment on op amp parameters.
2	Experiment on design of inverting and noninverting amplifier.
3	Experiment on design of linear applications using op amp (Adder-subtractor/Difference amplifier/ Integrator/Differentiator etc..)
4	Experiment on design of 1^{st} and 2^{nd} order of LPF/ HPF.
5	Experiment on implementation of op amp application (e.g., oscillator, Waveform generator etc..)
6	Experiment on non-linear application (e.g., comparator, Schmitt trigger, window comparator etc..) of op amp
7	Experiment on non-linear application (e.g., peak detector, Precision Rectifier) of op amp
8	Experiment on ADC / DAC interfacing
9	Experiments on IC 555 (Astable and mono-stable multi-vibrator)
10	Experiment on voltage regulator design using IC 723 for LVLC/ LVHC.
11	Experiment based on VCO 566 / PLL565
12	Experiment on implementation of instrumentation system (e.g., data acquisition).

Lab Code:	Lab Name	Credit
ELL 503	**Digital Communication LAB**	**1**

Prerequisite: Principles of Communication Engineering	
Lab Objectives:	
1	Implementation of various Digital Modulation & Demodulation techniques.
2	Generation and Reconstruction of Analog to Digital conversion. (PCM, & Delta Modulation)
3	Implementation of Source Coding Techniques. (Huffman Coding, Shannon Fano Coding)
4	Implementation of Channel Coding Techniques.
Lab Outcomes: Student will be able	
1	To understand basic theories of Digital Communication Systems..
2	To Implement different modulation and demodulation techniques.
3	To analyze digital modulation and demodulation techniques by using software simulation.
4	To identify and describe different techniques in modern digital communications, in particular source coding by using software simulation.
5.	To Perform Channel Coding Techniques.
6	To understand various line-coding techniques used in Communication.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**List of Experiments**
1	Line codes
2	Binary modulation techniques: BASK,BPSK,BFSK
3	M-ary modulation techniques: QPSK ,QAM
4	Minimum shift Keying
5	PDF and CDF of Rayleigh / Normal/ Binomial Distributions
6	Eye pattern, Power factor for PAM signal
7	Source encoding: Huffman coding for Binary symbols
8	Shannon-Hartley equation to find the upper limit on the Channel Capacity
9	Linear Block code : code generation, Syndrome
10	Cyclic code-code generation, Syndrome
11	Convolutional code-code generation from generator sequences
12	Generation of FHSS and DSSS signal
13	Error performance and Quality factor of QPSK/BPSK/MSK Modulation

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 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)
Continuous assessment exam	
1	Based on the subject and related lab of **ELC 504** and **ELL 503**

Course Code	Course Name	Credit
ELL 503	**Professional Communication and Ethics-II**	**2**

Prerequisite:Professional Communication and Ethics-I	
Course Objectives:	
1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code of ethics.
Course Outcomes: Student will be able	
1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5.	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour

Module		Topics	Hours
1		**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)**	**6**
	1.1	**Purpose and Classification of Reports:** **Classification on the basis of:** ● Subject Matter (Technology, Accounting, Finance, Marketing, etc.) ● Time Interval (Periodic, One-time, Special) ● Function (Informational, Analytical, etc.) ● Physical Factors (Memorandum, Letter, Short & Long	
	1.2	**Parts of a Long Formal Report:** ● Prefatory Parts (Front Matter) ● Report Proper (Main Body) ● Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports** ● Tense, Person & Voice of Reports ● Numbering Style of Chapters, Sections, Figures, Tables and ● Equations ● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals** ● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** ● Elements ● Scope and Limitations ● Conclusion	
2		**EMPLOYMENT SKILLS**	**6**
	2.1	**Cover Letter & Resume** ● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose** ● Importance of SOP	

		● Tips for Writing an Effective SOP	
	2.3	**Group Discussions** ● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	
	2.4	**Personal Interviews** ● Planning and Preparation ● Types of Questions ● Types of Interviews (Structured, Stress, Behavioural, Problem ● Solving & Case-based) ● Modes of Interviews: Face-to-face (One-to one and Panel) ● Telephonic, Virtual	
3		**BUSINESS MEETINGS**	**2**
	3.1	**Conducting Business Meetings** ● Types of Meetings ● Roles and Responsibilities of Chairperson, Secretary and Members ● Meeting Etiquette	
	3.2	**Documentation** ● Notice ● Agenda ● Minutes	
4		**TECHNICAL/ BUSINESS PRESENTATIONS**	**2**
	4.1	**Effective Presentation Strategies** ● Defining Purpose ● Analyzing Audience, Location and Event ● Gathering, Selecting & Arranging Material ● Structuring a Presentation ● Making Effective Slides ● Types of Presentations Aids ● Closing a Presentation ● Platform skills	

	4.2	**Group Presentations** ● Sharing Responsibility in a Team ● Building the contents and visuals together ● Transition Phases	
5		**INTERPERSONAL SKILLS**	**8**
	5.1	**Interpersonal Skills** ● Emotional Intelligence ● Leadership & Motivation ● Conflict Management & Negotiation ● Time Management ● Assertiveness ● Decision Making	
6		**CORPORATE ETHICS**	**2**
		6.1Intellectual Property Rights ● Copyrights ● Trademarks ● Patents ● Industrial Designs	
		Case Studies ● Cases related to Business/ Corporate Ethics	
		Total	**26**

Textbooks:	
1	Fred Luthans, “Organisational Behavior” , McGraw Hill, edition
2	Robbins Stephen judge timothy “Organisational Behavior” Pearson
3	R.C Sharma and Krishna Mohan, “Business Correspondence and Report Writing”
4	Foundation course in Human values and Professional Ethics L R R Gaur, R. Asthana, G.P. Bagaria
Reference Books:	
1	Lesiker and Petit, “Report Writing for Business” , McGraw Hill, edition
2	Wallace and Masters, “Personal Development for Life and Work” , Thomson Learning, 12th edition
3	B N Ghosh, “Managing Soft Skills for Personality Development”, Tata McGraw Hill.Lehman,

Internal Assessment:

Internal assessment will be for 50 Marks as given below

Sr No	Headings		Marks
A	Assignments		10 Marks
B	Continuous Assessment		20 Marks
C	a)Report	10 Marks	10 Marks
	b)Presentation	10 Marks	
D	Group Discussion		10 Marks
	Total		50 Marks

A) Assignments : List of assignments are as given below. The assignments have to be discussed in the group and approach approved by faculty. Each student in the group will have to write the assignments individually (10 Marks)

Sr No	List of Assignments
1.	Proposal
2.	Resume and Cover Letter /SOP
3.	Notice ,Agenda and Minutes of Meeting
4	Case Study /Role Play on Interpersonal Skills
5	Case study on Ethics

B)Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks

8.	Multiple Choice Questions (Quiz)	5 marks

C) Report on presentation: A detail typed report has to be prepared of minimum 25 pages and maximum 30 pages in the given format.

D) A final Group Discussion Round will be conducted and every student must participate in the group discussion

Tutorials will be conducted batch wise.

Course Code:	Course Name	Credit
ELM 501	**Mini Project - 2A**	**2**

Course Objectives:	
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:	
1	Identify analyze and solve problems based on societal /research needs in a group.
2	Develop interpersonal skills to work as member of a group or leaderand and demonstrate project management principles during project work
3	Draw the proper inferences from available results through theoretical /experimental /simulations.
4	Use standard norms of engineering practices.
5.	Excel in written and oral communication.
6	Demonstrate capabilities of self-learning in a group, which leads to life-long learning

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Major focus of Mini-project 2 shall be towards exploration and applicability of knowledge acquired in the domain areas of DLOs available for the year.
- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project

sustainable development goals (SDGs) to transform our world:

- Improve life for all of us. Cleaner air, Safer cities,Good health , Affordable and Clean Energy, Life Below Water and on land ,healthy planet.
- No poverty , Zero hunger, Equality, Better jobs,Industry, Innovation and Infrastructure

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 mini 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 Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-to-case basis

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 logbook: 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

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

1. First on identification and finalization of problem
2. Second on the proposed solution for the problem.

- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review shall base on readiness of building working prototype.
    - Second review shall be based on poster presentation-cum-demonstration of the working model in the last month of the said semester.

- **Half-year project:**

  In this case students' group shall complete project in all aspects, in a semester, including;

    - Identification of need/problem
    - Proposed acceptable solution for the identified problem
    - Procurement of components/systems, if any,
    - Building a working prototype and testing

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of the solution. (Innovative/out of box solution)

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey
a) Survey of Existing system
b) Limitations of Existing system or research gap
c) Problem Statement and Objective
d) Scope

iv. Proposed System
a) Analysis/Framework/ Algorithm
b) Details of Hardware & Software
c) Design details
d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Along with the project report a folders of project documentation, all literature survey papers, implemented code, required software, utilities, used component details, user manual etc, is to be submitted.

Assessment criteria of Mini Project.

Mini Project 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. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini- project.

In case of half year project all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

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

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Program Structure for Third Year Electronics Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Practical	Theory	Practical	Tutorial	Total
ELC601	Basic VLSI Design	3	-	3	-	-	3
ELC602	Electromagnetic Engineering	3	-	3	-	-	3
ELC603	Computer Communication Networks	3	-	3	-	-	3
ELC604	Embedded Systems and Real Time Operating Systems	3	-	3	-	-	3
ELDO601	Department Optional Course - II	3	-	3	-	-	3
ELL601	Basic VLSI Design Lab	-	2	-	1	-	1
ELL602	Computer Communication NetworksLab	-	2	-	1	-	1
ELL603	Embedded Systems and Real Time Operating Systems Lab	-	2	-	1	-	1
ELL604	Database Management Systems Lab	-	2* + 2	-	2	-	2
ELM601	Mini Project–2 B	-	4 $	-	2	-	2
	Total	15	14	15	07	-	22

* Theory class ; $ indicates workload of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ELC601	Basic VLSI Design	20	20	60	2	-	-	100
ELC602	Electromagnetic Engineering	20	20	60	2	-	-	100
ELC603	Computer Communication Networks	20	20	60	2	-	-	100
ELC604	Embedded Systems and Real Time Operating Systems	20	20	60	2	-	-	100
ELDO601	Department Optional Course - II	20	20	60	2	-	-	100
ELL601	Basic VLSI Design Lab	-	-	-	-	25	25	50
ELL602	Computer Communication NetworksLab	-	-	-	-	25	25	50
ELL603	Embedded Systems and Real Time Operating Systems Lab	-	-	-	-	25	25	50
ELL604	Database Management Systems Lab	-	-	-	-	50	–	50
ELM601	Mini Project–2 B	-	-	-	-	25	25	50
	Total	100	100	300	-	150	100	750

1. Digital Control System	3. Machine Learning
2. Digital Image Processing and Machine Vision	4. Digital Design with Reconfigurable Architecture

Course Code:	Course Title	Credit
ELC 601	**Basic VLSI Design**	**3**

Course Prerequisites: ● Electronics Devices and circuits – I (ELC302) ● Digital Logic Circuits (ELC303) ● Electronics Devices and Circuits – II (ELC402)	
Course Objectives:	
1	To understand VLSI Design flow and technology trends.
2	To realize MOS based circuits using different design styles.
3	To study semiconductor memories using MOS logic.
4	To study adder, multiplier and shifter circuits for realizing data path design.
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
2	Design and analyze MOS based inverters.
3	Understand different MOS circuit design styles.
4	Apply design styles for realization of Combinational and Sequential Circuits
5	Understand various semiconductor memories using MOS logic
6	Design adder, multiplier and shifter circuits using MOS logic

Module No.		Contents	Hrs.
1		**VLSI Design flow and Technology Trends**	06
	1.1	VLSI Design Flow: Full custom and Semi Custom IC design flow	
	1.2	MOSFET Scaling: Types of scaling, comparison of MOSFET Model levels, MOSFET capacitances, interconnect scaling and crosstalk	
	1.3	Technology Comparison: Comparison of BJT and MOS technologies	
2		**MOSFET Inverters**	08
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison	
	2.2	Static Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical voltages and noise margins	
	2.3	Design of symmetric CMOS inverter	
	2.4	Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay	
	2.5	Various components of power dissipation in CMOS circuits	
3		**MOS Circuit Design Styles**	06
	3.1	Static: Static CMOS, Pass transistor, Transmission gate, Pseudo NMOS design styles	
	3.2	Dynamic: C2MOS, Dynamic, Domino, NORA and Zipper design styles	
	3.3	Complex Boolean function realisation using various design styles	
4		**Combinational and Sequential Circuit Realization**	07
	4.1	Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realisation using equivalent CMOS inverter for simultaneous switching	
	4.2	Basic gates and MUX realisation using pass transistor and transmission gate logic	
	4.3	SR Latch, JK FF, D FF, 1 Bit Shift Register realisation using CMOS logic	
5		**Semiconductor Memories**	07
	5.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier	
	5.2	DRAM: 1T DRAM, operation modes, leakage currents, refresh operation, physical design	
	5.3	ROM Array: NAND and NOR based ROM array	
	5.4	Non-volatile read/write memories: Programming techniques for flash memory, Introduction to advances in non-volatile memories: MRAM, ReRAM	
6		**Data Path Design**	05
	6.1	Adder: CLA adder, MODL, Manchester carry chain High-speed adders: carry skip, carry select and carry save	
	6.2	Multipliers and shifter: Array multiplier and barrel shifter	
		Total	**39**

Textbooks:	
1	Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design” Tata McGraw Hill, Revised 4th Edition.
2	John P. Uyemura, “Introduction to VLSI Circuits and Systems”, Wiley India Pvt. Ltd.
Reference Books:	
1	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits: A Design Perspective”, Pearson Education, 2nd Edition
2	Douglas A Pucknell, Kamran Eshraghian, “Basic VLSI Design”, Prentice Hall of India Private Ltd.
3	Ivan Sutherlan and Bob Sproull, “Logical Effort: Designing Fast CMOS Circuits”
4	Etienne Sicard and Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, Tata McGraw Hill
5	Neil H. E. Weste, David Harris and Ayan Banerjee, “CMOS VLSI Design: A Circuits and Systems Perspective”, Pearson Education
6	David Hodges, Horace Jackson, Resve Saleh, “Analysis and Design of Digital Integrated Circuits”, McGraw-Hill, Inc.
7	Ashok K. Sharma, “Advanced Semiconductor Memories: Architectures, Designs, and Applications”, Wiley Publication
8	Denny D.Tang, Chi-Feng Pai, “Magnetic Memory Technology: Spin‐Transfer‐Torque MRAM and Beyond”, Wiley online Library
9	Daniele Ielmini, Rainer Waser, “Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications”, Wiley online Library

Course Code:	Course Title	Credit
ELC 602	**Electromagnetic Engineering**	**3**

Prerequisite:	
1	Vector Algebra (ELC301)
2	Engineering Physics
3	Electrical Network Analysis (ELC304)
4	Principles of Communication Engineering (ELC404)

Course Objectives:	
1	To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields.
2	To lay the foundations of electromagnetism and its practice in modern communications.
3	To provide an introduction to electromagnetic wave transmission through guided media.
4	To provide exposure to global safety standards in electromagnetic interference.

Course Outcomes: After successful completion of the course students will be able to:	
1	Apply vector calculus to static electric and magnetic fields in different engineering situations.
2	Analyze Maxwell's equations in different forms (differential and integral) and apply them to diverse engineering problems.
3	Analyze the phenomena of electromagnetic wave propagation in different media and in applications of microwave engineering.
4	Analyze the nature of electromagnetic wave propagation through transmission lines.
5	Evaluate and analyze different antenna structures and their applications.
6	Examine the sources of EMI and identify methods to ensure compatibility as per existing standards for electrical and electronic systems.

Module		Content	Hrs
1		**Basic Laws of Electromagnetic**	**10**
	1.1	Qualitative interpretation of Gradient, Divergence and Curl; Coulomb‘s Law & Electric Field Intensity, Derivation of electric field intensity due to point, line and surface charges; Electric flux density, Gauss‘s Law and divergence theorem; Relationship between Electric field & Potential.	
	1.2	Current and current Density, Continuity equation; Electric boundary conditions; Poisson‘s and Laplace's equation.	
		Biot-Savart‘s Law, Ampere‘s Circuital Law, magnetic field intensity of infinite current element; Magnetic flux density, Concept of magnetic scalar and vectors potentials; Magnetic boundary conditions.	
2		**Maxwell's Equations**	**6**
	2.1	Faraday‘s law, concept of transformer and motional electromotive forces; Displacement current, Ampere's Law for time-varying fields, Maxwell's equations in differential and integral form; Concept of time varying potentials, Lorentz gauge conditions	
	2.2	Concept of phasors and time harmonic fields	
3		**Electromagnetic Waves**	**6**
	3.1	Derivation of electromagnetic wave equation, General representation of EM waves	
	3.2	Wave Propagation in Free Space, Lossy and Lossless Dielectrics and in Good Conductors, Skin Effect, Wave Polarization, Poynting's Theorem; Introduction to microwaves as an EM wave application.	
4		**Transmission Lines**	7
	4.1	Transmission line parameters, Transmission line equations; Input impedance, reflection coefficient, standing wave ratio and power.	
	4.2	Smith Chart, Applications of Smith Chart in finding VSWR, reflection coefficient, admittance calculations and impedance calculations over length of line. Applications of Microstrip Lines.	
5		**Introduction to Antennas**	7

	5.1	Introduction to antennas and radiation mechanism; Basic antenna parameters: Radiation pattern, radiation power density, radiation intensity, HPBW, FNBW, directivity, Antenna radiation efficiency, Gain, bandwidth, polarization, input impedance, effective length, near and far field regions; FRIIS transmission equation.	
	5.2	Far-field radiating fields, radiation resistance and directivity of an infinitesimal dipole; Comparison between small dipole, finite length dipole and a half wavelength dipole	
6		**Introduction to EMI/EMC**	3
	6.1	Definition of EMI/EMC, introduction to sources and characteristics of EMI, EMI control techniques like grounding, shielding and filtering. EMC requirements for electronic systems, a review of MIL-standards, FCC and CISPR requirements.	
		Total	39

Textbooks:	
1	William H Hayt, John A Buck, Jaleel M. Akhtar, “Engineering Electromagnetics”, 9th ed., McGraw-Hill Higher Education, 2020.
2	Matthew N. O. Sadiku, S. V. Kulkarni, “Principles of Electromagnetics”, 6th ed., Oxford University Press, 2015.
3	R. K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill, 2005.
4	C. A. Balanis, “Antenna Theory: Analysis and Design”, 4th ed., John Wiley & Sons, NJ, 2015.
5	W. Prasad Kodali, “Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies and Computer Models”, 2nd ed., Wiley-IEEE Press, 2001.
6	Clayton R. Paul, “Introduction to Electromagnetic Compatibility”, John Wiley & Sons, 2nd ed., 2006.
Reference Books:	
1	John D. Kraus, Daniel A. Fleisch, “Electromagnetics: With Applications”, 5th ed., Tata McGraw Hill, 2010.
2	Joseph Edminister, Mahmood Nahvi, “Schaum's Outline of Electromagnetics”, 5th ed., McGraw Hill, 2018.
3	J. D. Kraus, R. J. Marhefka, A.S. Khan, “Antennas & Wave Propagation”, McGraw Hill Publications, 5th ed., 2017.
4	R. E. Collin, “Antennas and Radio Wave Propagation”, International Student Edition, McGraw Hill, 1985
5	Henry Ott, “Electromagnetic Compatibility Engineering”, Wiley, 2009.

Internal Assessment:
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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
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Course Code:	Course Title	Credit
ELC 603	Computer Communication and Networks	3

Course Prerequisites:

- ELC 404 Principles of Communication Engineering
- ELC 504 Digital Communication

Course Objectives:	
1	Introduce networking architecture and protocols.
2	Understand the various layers and protocols in the TCP/IP model.
3	Recognize different addressing schemes, connecting devices and routing protocols.
4	Select the required protocol from the application layer protocols.

Course Outcomes: **After successful completion of the course students will be able to:**	
1	Demonstrate understanding of networking concepts and required protocols.
2	Analyze the various layers and protocols of the layered architecture.
3	Evaluate different addressing schemes, connecting devices and routing protocols.
4	Analyze various routing protocols in Network layer.
5	Understand the various protocols in Transport layer
6	Comprehend the different protocols in application lay

Module No.		Contents	Hrs.
1	1.1	**Introduction to Network Architectures, Protocol Layers, and Service models** Introduction to computer networks and it's uses. LAN, MAN, WAN Network topologies **Addressing:** Physical / Logical /Port addressing, Protocols and Standards.	4
	1.1	**Protocol Architecture:** Need of layered protocol architecture, Layers details of OSI, Protocol Layers and Their Service Models	
	1.2	**TCP/IP Model:** Protocol suite, Comparison of OSI and TCP/IP	
2		**Physical Layer**	
	2.1	**Transmission Media:** Guided media like Coaxial, fiber, twisted pair, and Wireless media, Transmission Impairments. Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway	**06**
	2.2	**Introduction to LAN:** LAN Protocol architecture **Traditional Ethernet and IEEE 802.3 LAN Standard**: Ethernet protocol, Frame structure, Physical layers: LLC, MAC layers	
	2.3	**Multiplexing:** Synchronous TDM, Statistical TDM, ADSL	
3		**Data Link Control**	
	3.1	**Data link services:** Framing, Flow control, Error control, ARQ methods, Piggybacking	**10**
	3.2	**High Level Data Link Control (HDLC):** HDLC configurations, Frame formats, Typical frame exchanges.	
	3.3	**Medium Access Control Protocols**: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4		**Network Layer**	**10**
	4.1	**Switching**: Switched communication networks, Circuit switching networks, Circuit switching Concepts –Crossbar switch, Time Slot Interchange (TSI), TDM bus switching, Packet switching principles: Virtual circuit switching and Datagram switching	
	4.2	**Routing in Packet Switching Networks:** Characteristics, Routing strategies, Link state Routing, Distance vector Routing. Least-Cost Routing Algorithms: Dijkstra's Algorithm, Bellman Ford Algorithm.	
	4.3	**Internet Protocol:**	

		Principles of Internetworking: Requirements, Connectionless Operation **Internet Protocol Operation:** IP packet, IP addressing - classful and classless, subnet and supernet addressing, IPv4, IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6)	
5		**Transport Layer**	**06**
	5.1	**Connection –oriented Transport Protocol Mechanisms: Transmission Control Protocol (TCP):** TCP Services, TCP Header format, TCP three way handshake, TCP state transition diagram. **Connectionless transport mechanisms: User Datagram Protocol (UDP) -** header	
	5.2	**Congestion:** Effects of congestion, Congestion control methods, Congestion control in Packet switching Networks	
6		**Application layer**	**03**
	6.1	HTTP, FTP, DNS, Internet Telephony and Streaming Multimedia	
	6.2	Web Browsers (Google chrome , Firefox)	
		Total	**39**

Textbooks:	
1	William Stallings, "Data and Computer communications", Pearson Education, 10th Edition.
2	Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
3	Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second
Reference Books:	
1	S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition.
2	Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition.
3	Bhushan Trivedi, "Data Communication and Network", Oxford Publication Press, 1st edition.

Internal Assessment:
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Continuous Assessment:-
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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELC 604	**Embedded Systems and Real Time Operating Systems**	**3**

Course Prerequisites: ● Digital Electronics ● Basics of Microcontrollers	
Course Objectives:	
1	To study concepts involved in Embedded Hardware and Software for System realization.
2	To learn the concepts of modern microcontroller cores like the ARM-Cortex
3	To learn Real-time programming to design time-constrained embedded systems
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Identify and describe various characteristic features and applications of embedded systems.
2	Analyze and select hardware for embedded system implementation.
3	Evaluate various communication protocols for embedded system implementation.
4	Compare GPOS and RTOS and investigate the concepts of RTOS.
5	Evaluate and use various tools for testing and debugging embedded systems.
6	Design a system for different requirements based on life-cycle for the embedded system, keeping oneself aware of ethics and environmental issues.

Module No.		Contents	Hrs.
1		**Introduction to Embedded Systems**	**4**
	1.1	Definition, Characteristics, Classification, Applications	
	1.2	Design metrics of Embedded system	
2		**Embedded Hardware Elements**	
	2.1	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.	**11**
	2.2	ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map, Low Power modes and NVIC.	
	2.3	Communication Interfaces: Comparative study of Serial communication Interfaces -RS-232, RS-485, SPI, I2C, CAN, USB, Bluetooth, Zig-Bee. (Frame formats of above protocols are not expected)	
3		**Embedded Software**	**11**
	3.1	Embedded Programming in C: ALP and High level language programming, Headers, Preprocessor directives and source files, Macros and functions, Data types, modifiers and loops. Program Modeling concepts: DFG, CDFG, FSM.	
	3.2	Real-time Operating system: GPOS vs RTOS, Need of RTOS in Embedded system software. Task, Task states, Multi-tasking, Task scheduling, and algorithms-Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First.	
	3.3	Inter-process communication: Message queues, Mailbox, Event timers. Task synchronization: Need, Issues- Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. Shared Data problem, Priority inversion.	
4		**Introduction to FreeRTOS**	**05**
	4.1	FreeRTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Interrupt Management features, Time Management features.	
5		**Testing and Debugging Methodology**	**03**
	5.1	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	
	5.2	Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.	
6		**System Integration (Case Studies)**	**05**

	6.1	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model	
	6.2	Hardware-Software Co-design	
	6.3	Case studies for Automatic Chocolate Vending Machine, Washing Machine, Smart Card, highlighting i) Specification requirements (choice of components), ii) Hardware architecture iii) Software architecture	
		Total	**39**

Textbooks:	
1	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.
2	Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3	SriramIyer, Pankaj Gupta," Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4	Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
5	www.freertos.org
Reference Books:	
1	David Simon, "An Embedded Software Primer", Pearson, 2009.
2	Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
3	Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004
4	Frank Vahid, Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
5	Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.

Course Code:	Course Title	Credit
ELDO 6011	Digital Control System	3

Course Objectives:	
1	To develop the understanding of fundamental principles of digital control systems.
2	To disseminate the concept of stability and its assessment for discrete-time linear systems.
3	To introduce Z-transform methods and digital controller design.
4	To develop modern state-space methods in digital control systems design.
Course Outcomes: After successful completion of the course students will be able to:	
1	Employ sampling and reconstruction of analog signals.
2	Derive discrete-time models of physical systems.
3	Evaluate the stability of digital control systems in time and frequency domain.
4	Design performance specification based digital controller for a given system.
5	Analyse the digital control systems using state-space methods and design digital state feedback controllers

Module		Content	Hrs
1		**Fundamentals of discrete-time signals and discretization**	**4**
	1.1	Why study digital control systems? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system	
	1.2	Impulse sampling, Nyquist-Shannon sampling theorem, reconstruction discrete-time signals (Ideal filter).	
	1.3	Realizable reconstruction methods (ZOH and FOH), transfer functions of ZOH and FOH.	

2		**Modeling of Digital Control Systems**	06
	2.1	Discretization approaches: Impulse invariance, step invariance, bilinear transformation, finite-difference approximation of derivative.	
	2.2	Starred Laplace transform, Pulse transfer function and general procedures to obtain pulse transfer function.	
3		**Stability Analysis and Digital Controller Design**	10
	3.1	Mapping between s-plane and z-plane. stability analysis of digital systems in z-plane.	
	3.2	Transient and steady-state analysis of time response	
	3.3	Digital controller design using the root-locus method; digital PID controller; deadbeat controller	
	3.4	Realization of digital controllers: direct programming, standard programming, series programming, parallel programming ladder programming.	
4		**State-space Analysis of Discrete-time Systems**	09
	4.1	Discretization of continuous-time state-space solution and discrete time state-space model. Representation of difference equation to state-space.	
	4.2	Canonical forms for state-space representation and similarity transformations.	
	4.3	Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transform, Caley-Hamilton theorem, Diagonalization)	
5		**Controller Design in State-space**	08
	5.1	5.1 Concept of controllability, distinction between reachability and controllability, digital controller design using pole-placement methods (similarity transform, Ackerman's formula	
	5.2	Concept of observability, distinction between detectability and observability in discrete-time systems.	
	5.3	Observer design (prediction and current observer), output feedback controller, introduction to separation principle.	
		Total	39

Textbooks:	
1	Katsuhiko Ogata, “Discrete-time Control Systems”, 2nd edition, Pearson Education, 1995.
2	M. Gopal, “Digital Control and State Variable Methods”, Tata McGraw Hill, 4th edition, 2012.
Reference Books:	
1	Gene Franklin, J David Powell, Michael Workman, “Digital Control of DynamicSystems”, Addison Wesley, 3rd edition, 1998
2	B. C. Kuo, “Digital Control Systems”, Oxford University Press, 2nd edition, 2010

Internal Assessment:

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6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
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Course Code:	Course Title	Credit
ELDO 6012	**Digital Image Processing and Machine Vision**	**3**

Prerequisite: ● Engineering Mathematics – III (ELC301) ● Engineering Mathematics – IV (ELC401) ● Digital Signal Processing (ELC502)	
Course Objectives:	
1	To learn the fundamental concepts of image processing for image enhancement.
2	To learn image compression, segmentation techniques with practical applications.
3	To provide basic concepts of machine vision and application development.
Course Outcomes: After successful completion of the course students will be able to:	
1	Represent and interpret the image in its numeric and graphical form.
2	Perform different image enhancement approaches for improving image quality.
3	Elucidate the mathematical modelling of image segmentation.
4	Apply the concept of image compression.
5	Understand machine vision system elements.
6	Develop a machine vision system based on requirement.

Module		Content	Hrs
1		**Digital Image Processing Fundamentals**	**4**
	1.1	Introduction: Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model.	
2		**Enhancement in Spatial and Frequency Domain**	**9**
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging.	
	2.2	Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter, 2D-DFT/FFT of an image, Frequency domain image enhancement techniques.	
3		**Image Segmentation and Morphological Operations**	**10**
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based image segmentation, split and merge techniques. Image Representation and Description, Chain Code, Polygonal Representation.	
	3.2	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Thinning and Thickening.	
4		**Image Compression**	**5**
	4.1	Fundamentals: Coding Redundancy, Inter-pixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Improved Gray Scale Quantization, Transform Coding, JPEG Standard.	
5		**Machine Vision Basics**	**4**
	5.1	Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, Image Feature Extraction.	
6		**Machine Vision Applications in Industry**	**7**
	6.1	Machine Vision for Industrial Applications, Low Angle Metal Surface (Crosshead) Inspection, Machine Vision System for Quality Grading of Painted Slates, Inspecting Glass Bottles and Jars, Stemware Inspection System, Glass Thickness Measurement Using Morphology, Inspecting Food Products.	
		Total	**39**

Textbooks:	
1	Rafel C. Gonzalez and Richard E. Woods, ‘Digital Image Processing’, Pearson Education Asia, Third Edition.
2	Anil K. Jain, “Fundamentals and Digital Image Processing”, Prentice Hall of India Private Ltd, Third Edition.
3	Bruce G. Batchelor (Ed.), “Machine Vision Handbook”, Springer, 1st Edition.
	Peter Corke, “Robotics, Vision and Control”, Springer, 1st Edition..
Reference Books:	
1	S. Jayaraman, E.Esakkirajan and T. Veerkumar, “Digital Image Processing " TataMcGraw Hill Education Private Ltd, 2009.
2	Milan Sonka, Vaclav Hlavac, and Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Second Edition, Thomson Learning, 2001.
3	Zeuch, Nello, “Understanding and Applying Machine Vision”, CRC Press; 2nd edition.
4	Bershold Klaus, Paul Holm, “Robot vision”, The MIT press.

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4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	6 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO 6013	Machine Learning	3

Prerequisite: ● Linear algebra, multivariate calculus, and probability theory ● Neural Networks ● Knowledge of a programming language (PYTHON/C/C ++/ MATLAB recommended)	
Course Objectives:	
1	Apply Machine Learning techniques in real life applications.
2	Understanding nature of problems solved with Machine Learning
3	Understand learning process by human and Machine learning algorithms.
Course Outcomes: After successful completion of the course students will be able to:	
1	Develop Machine Learning Techniques which can be used in real world scenario.
2	Comprehend regression, classification that are used in machine learning.
3	Apply different Dimensionality reduction and clustering methods that are used in machine learning.
4	Analyze Dimensionality reduction techniques.
5	Understand the working of Probabilistic models6. Demonstrate understanding to real life problems

Module		Content	Hrs
1		Introduction to Machine Learning	4
	1.1	What is Machine Learning? Why Machine Learning?	
	1.2	Examples of Machine Learning Problems, Structure of Learning, Issues in Machine Learning	

	1.3	Applications of Machine Learning	
	1.4	How to choose Right Algorithm, Steps in Developing a Machine Learning Application	
	1.5	Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection	
2		**Classification and Regression**	**8**
	2.1	Binary Classification, assessing classification performance, Multi-class Classification	
	2.2	Linear regression, Logistic regression, Multi-class regression , Assessing performance of Regression- Error measures	
3		**Supervised Learning**	8
	3.1	Using Decision Trees, Constructing Decision Trees, Ranking and Probability estimation Trees, Classification and Regression Trees (CART)	
	3.2	Bayesian Logistic Regression, Naive Bay's classifier, Bayesian Belief Networks	
4		**Unsupervised learning**	8
	4.1	Dimensionality Reduction: Dimensionality Reduction Techniques, Principal Component Analysis (PCA)	
	4.2	K-means Clustering, Hierarchical Clustering, Expectation Maximization Algorithm, Supervised Learning after Clustering	
5		**Learning Models**	8
	5.1	Support Vector Machines, Maximum Margin Linear Separator	
	5.2	Quadratic Programming Solution to finding maximum margin separators, Kernels for learning non-linear functions	
6		**Case Studies In Machine Learning**	3
		Retail store sales prediction, Credit card Fraud detection (anomaly detection), healthcare, Telecommunications- Customer churn prediction	

Textbooks:	
1	Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Senseof Data”, Cambridge University Press.
2	Hastie, Tibshirani, Friedman, “Introduction to Statistical Machine Learning withApplications in R”, Springer, 2nd Edition, 2012
3	Peter Harrington, “Machine Learning In Action”, DreamTech Press.
Reference Books:	
1	Ethem Alpaydin, “Introduction to Machine Learning”, PHI 2nd Edition, 2013
2	C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 1st Edition,2013

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	7 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO 6014	**Digital Design with Reconfigurable Architecture**	**3**

Prerequisite: ● Digital Logic Circuits (ELC303)	
Course Objectives:	
1	To understand, analyze & design finite state machines (FSM)
2	To train students in writing VHDL code of combinational & sequential circuits
3	To prepare students to design FSM using hardware description languages (HDL)
4	To motivate students to use reconfigurable devices for digital systems.
Course Outcomes: After successful completion of the course students will be able to:	
1	Analyze & design FSM.
2	Understand fundamentals of HDL and its use for designing combinational circuits.
3	Apply the concept of HDL for designing sequential circuits.
4	Develop FSM by using the fundamentals of HDL.
5	Design of complex digital systems.
6	Understand and distinguish FPGA and CPLD architecture.

Module No.		Contents	Hrs.
1		**State Machines Design**	
	1.1	Mealy and Moore machines, clocked synchronous state machine design, state reduction techniques, State assignment, Clocked synchronous state machine analysis.	**08**
	1.2	Design examples on overlapping and non-overlapping sequence detector, Odd/even parity checker for serial data, vending machines.	
2		**Introduction to VHDL**	
	2.1	Core features of VHDL, Data types, Concurrent and Sequential statements, Data flow, Behavioral and Structural architectures, Subprograms: Function and Procedure.	**08**
	2.2	Design examples of combinational circuits like Multiplexers, De-multiplexers, Adder, Subtractor, Priority Encoder.	
3		**Design of sequential circuit using VHDL**	
	3.1	Design examples for Flip flops, Synchronous counters, Asynchronous counters, Shift registers	**06**
4		**Design of Finite State Machines (FSM) using VHDL**	
	4.1	VHDL programming for Moore, Mealy type FSMs, Sequence detector, Serial adders.	**06**
	4.2	VHDL programming for Traffic light controller, Vending machines applications.	
5		**System Design using VHDL**	
	5.1	Parallel Multiplication, Booth Multiplication algorithm with example and its VHDL code	**06**
	5.2	MAC unit, ALU, Memory: ROM and RAM and its VHDL code	
6		**Simulation, Synthesis and Implementation**	
	6.1	Functional simulation, Timing simulation, Logic synthesis, RTL. constants, parameters, wires and registers.	**05**
	6.2	CPLD, SRAM based FPGA architecture, Spartan II/Zybo	
		Total	**39**

Textbooks:	
1	M. Morris Mano,"Digital Design", 5th Edition, Pearson Education India, 2012.
2	John Wakerley, "Digital Design Principles & Practices" Pearson Publication, 3rd edition.
3	Volnei A. Pedroni, "Circuit Design with VHDL" MIT Press, 2004.
4	Wayne Wolf, "FPGA Based System Design" Pearson Education.
5	W. I. Fletcher, "Engineering Approach to Digital Design" PHI publications.
Reference Books:	
1	R. P. Jain, "Modern Digital Electronics", 4th Edition, McGraw Hill Education, 2016.
2	Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic Design" McGraw Hill, 2nd edition.
3	John M. Yarbrough, Digital Logic Applications and Design, Thomson Publications, 2006.
4	P. J. Ashenden, "The students guide to VHDL" Elsevier,1999.
5	Xilinx online resources – www.xilnix.com

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	8 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Lab Code:	Lab Name	Credit
ELL 601	Basic VLSI Design Lab	1

Course Objectives:	
1	To acquire SPICE coding / circuit simulators skills for realizing MOS based circuits
2	To compare and analyze performance of various MOS Inverters
3	To implement MOS based combinational and sequential circuits
Course Outcomes: After successful completion of the course students will be able to:	
1	Develop circuits using SPICE / circuit simulators.
2	Design and analyze MOS based inverters.
3	Verify different MOS circuit design styles.
4	Validate functionality of Combinational and Sequential Circuits using different design styles.
5	Examine various semiconductor memories using MOS logic.
6	Enhance skills of building adder, multiplier and shifter circuits using MOS logic.

Suggested List of Experiments

Sr. No.	Title of the Experiment
1	To write SPICE code for obtaining Transfer Characteristics (Id-Vg) and Output characteristics (Id-Vd) of enhancement and depletion type nMOS and pMOS transistors and extract parameter like subthreshold leakage current (I_L), threshold voltage (V_{T0}) and Subthreshold Swing (SS).
2	To study the impact of MOSFET scaling on the device performance.
3	To study the impact of MOSFET Model parameters in Level1 / Level2 on the drain characteristics.
4	To study the Voltage Transfer Characteristics (VTC) of resistive Load nMOS inverter and calculate high and low noise margins by extracting critical voltages. Also study the impact of variation of load resistance on VTC and hence on the noise margin.
5	To study the effect of Kr or transistor sizing on the VTC of CMOS inverter using SPICE simulation.
6	To analyse the transient performance of CMOS inverter.
7	To compare performance of different types of inverters by plotting their VTCs using SPICE code.
8	To realise the complex Boolean function using different design styles.
9	To realise Basic gates / MUX circuits using Pass transistor /Transmission gate logic.
10	To realise SR Latch, JK FF, D FF using MOS logic.
11	To realise SRAM /DRAM using MOS logic.
12	To realise adder / multiplier / shifter circuits.

Experiments can be performed using simulation tools such as NGSPICE, LTSPICE, DSCH2, etc.

Note:
Suggested List of Experiments is indicative. However, flexibility lies with individual course instructor to design and introduce new, innovative, problem based learning and challenging experiments, 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

Lab Code:	Lab Name	Credit
ELL 602	**Computer Communication Networks Lab**	**1**

Course Objectives:	
1	Introduce networking architecture and protocols.
2	Understand the various layers and protocols in the TCP/IP model.
3	Recognize different addressing schemes, connecting devices and routing protocols.
4	Select the required protocol from the application layer protocols.
Course Outcomes: After successful completion of the course students will be able to:	
1	Demonstrate understanding of networking concepts and required protocols.
2	Analyze the various layers and protocols of the layered architecture.
3	Evaluate different addressing schemes, connecting devices and routing protocols.
4	Analyze various routing protocols in Network layer.
5	Understand the various protocols in Transport layer
6	Comprehend the different protocols in application lay

Term Work:
Lab session includes Seven experiments and a case study (Power Point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.
2. Minimum Seven experiments need to be conducted, out of which at least Four experiments should be software-based (C/C++, Scilab, MATLAB, LabVIEW, etc).
3. Each student (in groups of 3/4) must present a Case study (Power point Presentation) as a part of the laboratory work.

4. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. (“Beyond the scope of the syllabus”.)
Power point presentation should contain minimum of 15 slides and students should submit a report, (PPT+REPORT) carry minimum of 10 marks. The term work assessment can be carried out based on the different tools and the rubric decided by the concerned faculty members and need to be conveyed to the students well in advance.

At least 07 experiments covering entire syllabus of ELL602 (CCN Lab) 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. Each student (in groups of 3/4) must present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology (“Beyond the scope of the syllabus”). Power point presentation should contain minimum of 15 slides and students should submit a report, (PPT+REPORT) carry minimum of 10 marks. 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

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

Experiment Title

1 Study of transmission media and interconnecting devices of communication networks.
2 Implementation of serial transmission using RS232.
3 Implementing bit stuffing algorithm of HDLC using C/C++.
4 Implementation of Routing protocols using C/C++.
5 Study of NS2 simulation software.
6 Implementation of TCP/UDP session using NS2.
7 Implementation of ARQ methods using NS2.
8 Study of WIRESHARK and analyzing Packet using WIRESHARK.
9 Study and implementation of IP commands.
10 Study of GNS software and implementation of routing protocols using GNS.

All the experiments can be performed using simulation softwares. (Free simulation software Scilab can be used)

Note: Suggested List of Experiments is indicative. However, flexibility lies with the 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

Lab Code:	Lab Name	Credit
ELL 603	**Embedded Systems and Real Time Operating Systems Lab**	**1**

Prerequisite: ● Basics of Microcontroller programming ● C programming	
Course Objectives:	
1	To design and write efficient code for single-tasking and multi-tasking embedded systems
Course Outcomes: After successful completion of the course students will be able to:	
1	Interface various sensors and actuators to embedded cores.
2	Write code using RTOS for multi-tasking Embedded systems
3	Design applications using different embedded cores

Term Work:

At least 10 experiments covering entire syllabus of Embedded Systems and Real Time Operating Systems (ELC604) 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.

1. Students must perform the experiments using Simulation as well as in Hardware.
2. Experiments must include a minimum of 3 experiments using FreeRTOS

Suggested List of Experiment

Sr. No.	Experiment Name
1	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)
2	Interfacing of Temperature sensor with any embedded core. (8051/ARM/STM32, etc)
3	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32, etc)
4	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM/STM32, etc)
5	Interfacing of a relay with any embedded core. (8051/ARM/STM32, etc)
6	Interfacing of a DC motor (speed and Direction control) with any embedded core. (8051/ARM/STM32,etc)
7	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM/STM32, etc)
8	Implement power management in any embedded core of your choice
9	Implement the I2C communication to connect to DS1307 RTC
10	Porting of FreeRTOS to Arduino/STM32.
11	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS (FreeRTOS).
12	Write a Program to illustrate the Queue Management Features of FreeRTOS.
13	Write a Program to illustrate the Event Management Features of FreeRTOS.
14	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronization using FreeRTOS.
15	Build a Multitasking Real-Time Applications using the above IPC Mechanisms (Message Queue, EventGroup, Semaphores) with FreeRTOS on Arduino/STM32

Lab Code	Lab Name	Credit
ELL 304	**Database Management Systems Lab**	**1**

Lab Outcomes:	
1	Design ER /EER diagram and convert to relational model for the realworld application.
2	Apply DDL, DML, DCL and TCL commands.
3	Write simple and complex queries
4	Use PL/SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions

10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

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.

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 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)
Continuous Assessment Exam	
1	Based on the subject and related lab

Lab Code	Lab Name	Credit
ELM 601	Mini project - 2B	2

Course Objectives:	
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:	
1	Identify analyze and solve problems based on societal /research needs in a group.
2	Develop interpersonal skills to work as member of a group or leaderand and demonstrate project management principles during project work
3	Draw the proper inferences from available results through theoretical /experimental /simulations.
4	Use standard norms of engineering practices.
5.	Excel in written and oral communication.
6	Demonstrate capabilities of self-learning in a group, which leads to life-long learning

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Major focus of Mini-project 2 shall be towards exploration and applicability of knowledge acquired in the domain areas of DLOs available for the year.
- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project

sustainable development goals (SDGs) to transform our world:

- Improve life for all of us. Cleaner air, Safer cities,Good health , Affordable and Clean Energy, Life Below Water and on land ,healthy planet.
- No poverty , Zero hunger, Equality, Better jobs,Industry, Innovation and Infrastructure

  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 mini 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 Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-to-case basis

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 logbook: 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

- In first 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 on identification and finalization of problem
    - ❖ Second on proposed solution for the problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - ❖ First review shall base on readiness of building working prototype.
    - ❖ Second review shall be based on poster presentation-cum-demonstration of working model in last month of the said semester.

- **Half-year project:**

  In this case students' group shall complete project in all aspects, in a semester, including;

    - Identification of need/problem
    - Proposed acceptable solution for the identified problem
    - Procurement of components/systems, if any,
    - Building a working prototype and testing

Two reviews will be conducted for continuous assessment,

- ❖ First shall be for finalization of problem and proposed solution
- ❖ Second shall be for implementation and testing of solution.

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey

a) Survey of Existing system

b) Limitations of Existing system or research gap

c) Problem Statement and Objective
d) Scope

iv. Proposed System
a) Analysis/Framework/ Algorithm
b) Details of Hardware & Software
c) Design details
d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Along with the project report a folders of project documentation, all literature survey papers, implemented code, required software, utilities, used component details, user manual etc, is to be submitted.

Assessment criteria of Mini Project.

Mini Project 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. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Full functioning of working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication
    -

- In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini-project.

- In case of half year project all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini 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 the Institute
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Continuous Assessment:
A student shall be assessed based on various rubrics associated with the subject.

Program Structure for Final Year Electronics Engineering Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	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	06	21

# Indicates workload of Learner (Not Faculty)

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ELC701	Power Electronics	20	20	60	2	-	-	100
ELC702	Internet of Things	20	20	60	2	-	-	100
ELDO701	Department Optional Course – 3	20	20	60	2	-	-	100
ELDO702	Department Optional Course – 4	20	20	60	2	-	-	100
ELIO701	Institute Optional Course - 1	20	20	60	2	-	-	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	100
	Total	100	100	300	-	125	125	750

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 Title	Credit
ELC701	**Power Electronics**	**03**

Prerequisite:	
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 designDC-AC converters.
6	Illustrate, analyze and design AC-AC converters.

Module		Content	Hrs
1		**Power Semiconductor Devices**	**04**
	1.1	Principle of operation and characteristics of: SCR, TRIAC, DIAC, GTO, MOSFET and IGBT.Comparison between components.	
2		**Triggering, Commutation and Protection**	**06**
	2.1	Thyristor Turn-on Methods,Firing circuits for Thyristors.TRIAC firing circuits.	
	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 (Single Phase)	
4		**DC-DC Converters**	**8**
	4.1	Buck, Boost and Buck-Boost converters	
	4.2	DC-DC converters with R and RL load.	
5		**DC-AC Converters**	**8**
	5.1	Principle of operation and performance parameters.(Single Phase)	
	5.2	Voltage control of single phase inverters	
6		**AC-AC Converters**	**7**
	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**

Textbooks:	
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:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELC702	**Internet of Things**	**03**

Prerequisite:	
1	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		Content	Hrs
1		Introduction to IoT	**5**
	1.1	Definition and Characteristics of IoT	
		IoT Protocols	
		IoT Functional Blocks	
		IoT Communication Models	
	1.2	IoT Communication APIs :- REST and WebSockets	
		IoT Enabling Technologies	
		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	
		Applications of RFID and WSN in IoT	
		Exemplary Device:- R–Pi and its Interfaces, PCDuino, BeagleBone	
3		Data Handling in IoT	**9**
	3.1	Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics	
	3.2	Data Collection, Storage and Computing Using Cloud Platform,	
	3.3	Introduction to Cloud Computing, Virtualization, Cloud Models, Cloud Services	
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	
		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 Study on Home automation, Case Study on Weather Monitoring	
	5.2	IoT Levels and Deployment Templates	
6		IoT Security and Vulnerabilities Solutions	**4**
	6.1	IoT Security Tomography and Layered Attacker Model	
	6.2	Identity Management, Establishment, Access Control and Secure Message Communication,	
		Security Protocols	
		Total	**39**

Textbooks:	
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:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELDO7011	**Mixed Signal VLSI Design**	**03**

Prerequisite:

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

1	Know operation of the various building blocks of analog and mixed signal VLSI circuits.
2	Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits.
3	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.
4	Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
5	Evaluate and select appropriate circuit/configuration for given application.
6	Design analog and mixed signal VLSI circuits for given application.

Module 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**	**09**
	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	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	04
3.0		**Noise in MOS Circuits (Numerical not expected)**	**05**
	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	02
	3.3	Noise in differential pairs, noise bandwidth	01
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**

Textbooks:	
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

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Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
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2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
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4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELDO7012	Embedded GPU	3

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:	
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 field.

Module 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**

Textbooks:	
1	Computer Architecture -- A Quantitative Approach‖ - John L.Hennessy and DavidA. 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/CRCComputational Science.
3	Modern Processor Design: Fundamentals of Superscalar Processors, Shen, John Paul,Lipasti, Mikko H.
4	4. General-Purpose Graphics Processor Architecture – Tor M. Aamodt, Wilson WaiLun Fung, Timothy G. Rogers, Morgan and Claypool Publishers.
5	https://coreavi.com/wp-content/uploads/CoreAVI-White-Paper-Weighing-theFactors-of-Discrete-Versus-Embedded-GPUs.pdf.

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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

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Course Code:	Course Title	Credit
ELDO7013	**Artificial Intelligence**	**3**

Prerequisite: Basic Python Programming	
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:	
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.

Module 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 Ethics in AI present of AI,state	
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, Optimization: Genetic Algorithm	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search	
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, forward Chaining, Backward Chaining	
5		**Reasoning Under Uncertainty**	**5**
	5.1	Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability	
	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**

Textbooks:	
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:
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Continuous Assessment:-
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End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO7014	**Advanced Networking Technology**	**3**

Prerequisite: Knowledge of computer Networks	
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.		Contents	Hrs.
		Wireless LAN and WAN Technologies	
1	1.1 1.2 1.3	Introduction to Wireless networks : Infrastructure networks, Ad-hoc Networks IEEE 802.11 architecture and services, Medium Access Control sub layers, CSMA/CA, Physical Layer, 802.11 Security considerations Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM cells , ATM Functional Layers, Congestion control and Quality of service	08
2	2.1 2.2	**Optical Networking** SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks DWDM: Frame format, DWDM architecture, Optical Amplifier, Optical cross connect Performance and design considerations.	06
3	3.1 3.2	**Routing in the Internet** Intra and inter domain Routing, basics of Unicast Routing Protocols: RIP, OSPF, BGP Introduction to Multicast Routing Protocols , Drawbacks of traditional Routing methods.	06
4	4.1 4.2	**Network Security** Security goal, Security threats, security safeguards, firewall types Internet Security: Network Layer Security, Transport Layer Security, Application Layer Security	08

5	 **5.1** **5.2**	**Multimedia Information and Networking** Compression Fundamentals, Digital Representation, Compression techniques, Multimedia Communication across networks, RTP, SIP, H.323	**06**
6	 **6.1** **6.2**	**Network Design** 3 Tier network design layers , application layer , access layer Backbone layer. Ubiquitous & Hierarchical computing Self Study - Case study on Network design	**05**
		Total	**39**

Textbooks:	
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

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4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO7021	**Wireless Communication**	**3**

Prerequisite: 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 communicationsystem‘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 standard.

Module No.		Contents	Hrs.
1		**Introduction to the Cellular Communication**	6
	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 & Cochannel 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.**	8
2		**Mobile Radio Propagation**	
	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**	6
3		**Spread spectrum Modulation and Multiple Access Techniques**	
	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**	
	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	**5**	**GSM**	**6**
	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**	**8**
	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**

Textbooks:	
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, TataMcGraw 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 KaufmannPublishers an Imprint of Elsevier, USA 2009 (Indian Reprint).
3	William Stallings, ―Wireless Communications & Networks‖, 2nd edition, PrenticeHall, 2004.
4	Wei Xiang & Kan Zheng, ―5G Mobile Communications‖, 1st Springer, 2017.
5	Saad Asif, ―5G Mobile Communications Concepts and Technologies‖, 1st CRCPress, 2018

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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO7022	**Cloud Computing**	**3**

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:	
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 of open source cloud.
5	Identification of threats and cloud-based risks for cloud security.
6	Understand cloud applications and recent trends.

Module No.		Contents	Hrs.
	0	**Pre-requisites:** Basics of operating system (O.S.), ISO-OSI model and its layers	2
1	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	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	

	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-asa-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**	**7**
	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	
	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**	**7**
	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.	
	5.3	AAA model, automatic security establishing trusted cloud computing, secure execution environments and communications, access control, disaster recovery in clouds.	
		Self-learning topics: Explore open source cloud and edge computing platform for an enterprise: Open Nebula.	
	6	**Cloud Applications and Recent Trends**	**6**
	6.1	**Cloud Applications:**	
		Scientific Applications: Healthcare: ECG analysis in cloud IoT-enabled Cloud Applications: Smart Agriculture	
		Business and Consumer Applications:CRM and ERP, Productivity, networking, media applications, multiplayer online gaming	
		Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing.	
		Total	39

Textbooks:	
1	Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing.
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
Reference Books:	
1	Cloud Computing Black Book by Kailash Jayaswal, Jagannath Kallakurchi, DonaldJ. Houde, Deven Shah, Dreamtech Press
2	Amazon Web Services in Action by Michael Wittig, Andreas Wittig, ManningPublisher
3	To the cloud: cloud powering an Enterprise, Arora Pankaj, Tata Mc Graw HillEducation
4	Distributed and Cloud Computing: From Parallel Processing to the Internet ofThings, Kai Hwang, Morgan Kaufmann.

Course Code:	Course Title	Credit
ELDO7023	**Robotics**	**3**

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: **After successful completion of the course students will be able to:**	
1	Understand the basic concepts and classification 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.		Contents	Hrs.
1		**Fundamentals of Robotics**	04
	1.1	Robot Classification, Robot Components, Robot Specification	
	1.2	Joints, Coordinates, Coordinate frames, Workspace,Applications	
2		**Kinematics of Robots**	11
	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 two DOF, Three DOF and Four DOF (SCARA) robots	
3		Differential motions and velocities of robots	06
	3.1	Differential relationship, Jacobian, Differential motion of a frame and robot, Singularities	
4		**Trajectory planning, Path Planning and Task Planning**	10
	4.1	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	
	4.2	Bug 1 , Bug 2 and Tangent Bug Algorithm, A* search Algorithm, Simulated Annealing	
	4.3	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning	
5		**Robot Vision and Sensors**	04
	5.1	Image representation, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform	
	5.2	Touch sensors, Tactile sensor, Proximity and range sensors, Light sensors, Pressure sensors	
6		**Application of Robotics**	04
	6.1	Areial Robots, Humanoid and Under water	
		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-HillEducation., 2009.
2	Richard D. Klafter, Thomas .A, ChmiElewski, Michael Negin, "Robotics Engineering anIntegrated Approach", PHI Learning, 2009.
3	Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice HallInc., 1987.
4	P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw HillPublishing 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.,19858. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, —Robot Modeling & Control ‖,Wiley India Pvt. Ltd., 2006

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Code:	Course Title	Credit
ELDO7024	**Data Science and Application**	**3**

Prerequisite: Knowledge of computer Networks	
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

Module No.		Contents	Hrs.
1		**Introduction**	6
	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.	
	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**	6
	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	
3		**The Data Science Process**	
	3.1	**Overview of Data Science Process, Step1- Defining Research Goals and creating project charter**	6
	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	
4		**Data Science and Machine Learning**	8
	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.	
	4.4	**Confusion Matrix, Case Study**	6
5		**Data Science and NoSQL Databases**	
	5.1	Introduction to NoSQL ACID the core principles of Relational databases, CAP Theorem, The BASE Principles of NoSQ	

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

Textbooks:	
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 ofData Science‖, Thakare, Taylor and Francis Group, CRC Publication.
3	Dr. Vijayalakshmi and Dr. Radha Shankarmani ―Big Data Analytics‖, WileyPublication
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‖, Wile

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Lab Code	Lab Name	Credit
ELL701	**Power Electronics Lab**	**1**

Prerequisite:	
1	Electronic Devices and Circuits (ELC302)
2	Electrical Network Analysis (ELC304)
Lab 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.
Lab Outcomes: Student will be able	
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 designDC-AC converters.
6	Illustrate, analyze and design AC-AC converters.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Experiment Title
1	To study V-I characteristics of SCR.
2	To study V-I characteristics of DIAC
3	To study V-I characteristics of TRIAC
4	To study triggering circuits for SCR : R Triggering circuit
5	To study triggering circuits for SCR : RC Triggering circuit
6	To study class B commutation circuit of SCR.
7	To study Half wave controlled rectifiers using SCR.
8	To study AC phase control circuits using DIAC and TRIAC.
9	To study uncontrolled rectifiers.
10	To study controlled rectifiers.
11	To Study a controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.
12	To study buck and boost converters.
13	To study single phase DC to AC converters.
14	To study AC to AC converters.

Term Work:	
1	At least 10 experiments covering the entire syllabus of ELL501 (Power Electronics) should be set to have well predefined inference and conclusion.
2	The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting.
3	Simulation experiments are also encouraged.
4	Experiments must be graded from time to time.

5	The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged.
6	The grading and term work assessment should be done based on this scheme.
7	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
8	Practical and Oral exam will be based on the entire syllabus.
Continuous assessment exam	
1	Based on the subject and related lab of **ELL701 & ELC701**

Course Code:	Course Title	Credit
ELL703	**Mixed Signal VLSI Design**	**1**

Prerequisite: Basic VLSI Design	
Lab Outcomes:	
1	Students will be able to design and simulate single stage amplifier circuits.
2	Students will be able to design and simulate different types of current mirror circuits.
3	Students will be able to design and simulate differential amplifier and OPAMP.
4	Students will be able to design and simulate mixed mode circuits.

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

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

Lab Code	Lab Name	Credit
ELL703	**Artificial Intelligence Lab**	**1**

Prerequisite: Python Programming Language.	
Lab Outcomes:	
1	Identify suitable Agent Architecture for a given real world AI problem.
2	Implement various search techniques for a Problem-Solving Agent.
3	Represent natural language description as statements in Logic and apply inference rules to it.
4	Construct a Bayesian Belief Network for a given problem and draw probabilistic inferences from it.

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	Implement any one of the Uninformed search techniques
4	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
5	Implement adversarial search using min-max algorithm.
6	Implement any one of the Local Search techniques. E.g. Hill Climbing, Simulated Annealing, Genetic algorithm
7	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.
8	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)
9	Implement a Planning Agent
10	Design a prototype of an expert system
11	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	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments performance: 20-marks, Attendance of Practical: 05-marks)
Oral & Practical exam	
Based on the entire syllabus	

Lab Code	Lab Name	Credit
ELL703	**Advanced Networking Technologies**	**1**

Term Work:

At least 08 experiments covering the entire syllabus of 701 lab (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.

Suggested List of Experiments

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.

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/

Course Code	Course Name	Credit
ISP 701	**Major project - I**	**3**

Course Objectives:	
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.
5	To enable the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a social real life problem or an issue, and mapped with 17 sustainable development goals (SDGs) to transform our world via a substantial piece of work which is to be carried out over an extended period.
Course Outcomes:	
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.Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
8	Demonstrate capabilities of self-learning in a group, which leads to life-long 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.

The 17 sustainable development goals (SDGs) to transform our world:

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to achieve the Goal

Guidelines for Assessment of Major Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each 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 logbook: 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05

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. Innovativeness and out of box thinking
6. Cost effectiveness and 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 the Institute.
- **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. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey

a) Survey of Existing system

b) Limitations of Existing system or research gap

c) Problem Statement and Objective

d) Scope

iv. Proposed System

a) Analysis/Framework/ Algorithm

b) Details of Hardware & Software

c) Design details

d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Along with the project report a DVD/ pen drive consisting of folders of project documentation, all literature survey papers, implemented code, required software, utilities, used component details, user manual etc, is to be submitted.

Number of copies of the project report to be submitted: 2+ No. of students in the group

Oral & Practical examination of Project-I should be conducted by Internal and External examiners approved by Academic council/ Exam cell. Students have to give presentation and demonstration on the Project-I.

Continuous Assessment:
A student shall be assessed based on various rubrics associated with the subject.

Program Structure for Final Year Electronics Engineering Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ELC801	Industrial Automation	3	-	3	-	3
ELDO801	Department Optional Course – V	3	-	3	-	3
ELDO802	Department Optional Course – VI	3	-	3	-	3
ELIO801	Institute Optional Course - 2	3	-	3	-	3
ELL801	Industrial Automation Lab	-	2	-	1	1
ELL802	Department Optional Course – V Lab	-	2	-	1	1
ELP801	Major Project II	-	12#	-	6	6
	Total	12	16	12	08	20

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA					
ELC801	Industrial Automation	20	20	60	2	-	-	100
ELDO801	Department Optional Course – V	20	20	60	2	-	-	100
ELDO802	Department Optional Course – VI	20	20	60	2	-	-	100
ELIO801	Institute Optional Course - 2	20	20	60	2	-	-	100
ELL801	Industrial Automation Lab	-	-	-	-	25	25	50
ELL802	Department Optional Course – V Lab	-	-	-	-	25	25	50
ELP801	Major Project II	-	-	-	-	50	100	150
	Total	80	80	240	-	100	150	650

Department Optional Courses:

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

Institute Optional Course – II (Semester- VIII)

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

Course Code:	Course Title	Credit
ELC801	**Industrial Automation**	03
Prerequisite:		
1	Knowledge of Fundamentals of Sensors and Industrial Measurement.	
Course Objectives:		
1	To impart knowledge about the fundamentals of automation and various automation systems used in industry.	
2	To impart the knowledge about the architecture, working and applications of PLC.	
3	To impart the knowledge about the architecture, working and applications of DCS.	
4	To impart the knowledge about the architecture, working and applications of SCADA.	
5	To impart the knowledge about the Database, AMS, MES & ERP.	
6	To make the students understand HAC and the requirements of Safety Instrumented industry	
Course Outcomes: After successful completion of the course students will be able to:		
1	Describe automation, need, importance and applications in industry	
2	Develop PLC programs using ladder instructions for the process applications	
3	Explain architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method.	
4	Describe SCADA architecture, communication in SCADA systems.	
5	Explain database and alarm management system, MES as well as ERP.	
6	Classify Hazardous area and recognize the need of SIS and describe risk reduction methods.	

Module		Content	Hrs
1		**Fundamentals of Industrial Automation**	**6**
	1.1	Automation: definition, need importance, expectations and its applications, Types of automation-Process and factory automation, Types of Automation systems: fixed, programmable, flexible, integrated	
	1.2	Types of plant and control – categories in industry, open loop and closed loop control functions, continuous processes, discrete processes, and mixed processes, **types of control actions- P, I, D, PI and PID**. discrete and continuous controllers.	
	1.3	Automation hierarchy – large control system hierarchy, data quantity and quality, hierarchical control	
2		**Programmable Logic Controller**	**10**
	2.1	Evolution and **Need** of PLC, Definition, functions of PLC, advantages, architecture (hardware and software)- controller, input and output (I/O) modules, types of PLCs, working of PLC, scan time	
	2.2	Local and remote I/O expansion, special purpose modules, wiring diagrams of different input and output modules, communication modules, Memory and addressing- memory organization, I/O addressing, hardware to software interface Introduction to PLC Programming, programming devices,	
	2.3	PLC programming languages as per IEC standard, Ladder diagram (LD) programming-relay type, timer and counter, arithmetic, data comparison data transfer and program control instructions.	
3		**Distributed Control System**	
	3.1	Introduction to DCS, generic architecture of DCS (hardware and software) -controller, I/O modules, communication module, data highway, local I/O bus, workstations.	**8**
	3.2	Supervisory computer functions, DCS and Supervisory computer displays- group, detailed, trend and graphic, hierarchical computer system and their functionalities, network access protocols	
	3.3	Computer interface with DCS- hardware and software, Introduction to DCS Programming-Function Block Diagram method	
4		**Supervisory Control And Data Acquisition**	**7**
	4.1	Introduction-overview of SCADA system, brief history of	

		SCADA, Features of SCADA, functionalities of SCADA system	
	4.2	Generic elements of SCADA system: central host computer, master terminal units (MTU), remote terminal unit(RTU), operator interface(Man machine interface), Data Communication components, methods, technologies, communication media and protocol structure.	
	4.3	Common applications and Industry specific applications of SCADA.	
5		**Database and Alarm Management, MES, ERP**	**4**
	5.1	Introduction to Database management and alarm management system. **Types of Alarms**.	
	5.2	Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Integration with enterprise system	
6		**Hazardous Areas and Safety Instrumented System (SIS)**	**4**
	6.1	**Hazardous area classification**, Need for safety instrumented system, components of SIS,characteristics of SIS, risk and risk reduction methods, Process control systems andSIS, layers of protection	
	6.2	Safety instrumented functions, Safety Integrity Levels, risk reduction factor and safety availability, functional safety standards	
		Total	**39**

Textbooks:	
1	Thomas Hughes, ―Programmable Logic Controller‖, ISA Publication, 2001.
2	Samuel M. Herb, ―Understanding Distributed Processor Systems for Control‖, ISA Publication, 1999.
3	Stuart A. Boyer, ―SCADA: Supervisory Control and Data Acquisition‖, ISA Publication, 2010.
4	Gruhn and Cheddie, ―Safety Shutdown Systems‖, ISA Publication, 1998.
5	Curtis D. Johnson, ―Process Control Instrumentation Technology‖, 8th edition, Prentice Hall of India, 2014.
Reference Books:	
1	Bela G. Liptak, ―Instrument Engineer‘s Handbook‖, Process control Chilton book, 3 rd edition.
2	Krishna Kant, ―Computer Based Process Control‖, Prentice Hall of India, 2nd edition, 2010.
3	Gary Dunning, ―Introduction to Programmable Logic controller‖, Thomas Learning, edition, 2001.
4	S.K. Singh, ―Computer Aided Process Control‖, Prentice Hall of India, 2004.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code:	Course Title	Credit
ELDO 8011	**Micro Electro Mechanical Systems**	03
Prerequisite:		
1	Basic Electronics	
Course Objectives:		
1	To provide a basic knowledge of MEMS processing steps and processing modules.	
2	To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.	
3	To provide an understanding of basic design and operation of MEMS sensors and transducers.	
Course Outcomes: After successful completion of the course students will be able to:		
1	**Derive** Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication	
2	**Analyze** Draw various plots in time and frequency domain for the MEMS devices and **analyze** the system using the plots.	
3	**Evaluate** the stability of micro-electro-mechanical- systems in time and frequency domain.	
4	**Design** Design and simulate MEMS devices and system using standard simulation tools.	
5	**Design** Develop different concepts of micro system sensors and actuators for realworld applications.	
6	**Analyse** the behaviour of MEMS devices using simulation softwares **Note:** The action verbs according to Bloom's taxonomy are highlighted in bold	

Module		Content	Hrs
1		**Introduction to MEMS**	**4**
	1.1	Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors).	
	1.2	MEMS Sensors in Internet of Things (IoT), BioMedical Applications.	
2		**Understanding MEMS Materials & their Properties for Device Applications**	**7**
	2.1	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt)	
	2.2	Important properties for MEMS: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications.	
3		**MEMS Fab Processes – 1**	**7**
	3.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography.	
	3.2	Advanced Lithography Techniques (EBL).**Understanding selection of Fab processes based on Applications**	
4		**MEMS Fab Processes – 2**	**8**
	4.1	Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining	
	4.2	DRIE, Die, Wire & Wafer Bonding, Dicing, Packaging. **Understanding selection of Fab processes based on Applications**	
5		**MEMS Devices**	**8**
	5.1	Architecture, working and basic **quantitative** behaviour of	

		Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating Microheater & cantilever only.	
	5.2	**MEMS Sensors, Actuators and Structures** MEMS Sensing and actuation (Capacitive, Piezo electric Piezo resistive)	
6		**MEMS Device Characterization**	**5**
	6.1	Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behaviour, MEMS Reliability.	
		Total	**39**

Textbooks:	
1	N. Maluf, K Williams;"An Introduction to Microelectromechanical Systems Engineering"; 2 nd Ed -; Publisher: **Artech House Inc**
2	Ville Kaajakari "Practical MEMS "; Publisher: **Small Gear Publishing**
3	S. Senturia "Microsystem Design"; Publisher: **Springer**
Reference Books:	
1	Minhang Bao, "Analysis and Design Principles of MEMS Devices"; Publisher: **Elsevier Science**
2	M. Madou, "Fundamentals of Microfabrication"; Publisher: **CRC Press; 2 edition**
3	J. Allen, "Micro Electro Mechanical System Design"; Publisher: **CRC Press**
4	G. Kovacs, "Micromachined Transducers Sourcebook"; Publisher: **McGraw-Hill**
5	Wanjun Wang, Steven A. Soper," Bio-MEMS Technologies and Applications"; Publisher: **CRC Press**, First Edition.
6	Tai-Ran HSU,"MEMS &Microsystems: Design And Manufacture"; Publisher **Tata Mc-Hill** **Journals:** Refer to review papers in IEEE Journal of Microelectromechanical Systems

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Continuous Assessment:-
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Sr.no	Rubrics	Marks
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6.	GATE Based Assignment test/Tutorials etc	10 marks
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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
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Course Code:	Course Title	Credit
ELDO8012	**Web Design**	**3**

Prerequisite: Basics of programming languages, knowledge of HTML & computer networks.	
Course Objectives:	
1	To design and create web pages using HTML5 and CSS3.
2	To implement client side scripting to static web pages.
3	To create dynamic web pages using server side scripting.
4	To use MVC framework for web application development.
Course Outcomes:	
1	Design static web pages using HTML5.
2	Design the layout of web pages using CSS3.
3	Apply the concepts of client side validation and scripts to static web pages using JavaScript and ReactJS.
4	Build responsive web pages using front-end framework Bootstrap.
5	Build dynamic web pages using server side scripting.
6	Develop a web application using appropriate web development framework.

Module	Unit No.	Contents	Hrs
1		**Introduction to HTML5**	04
	1.1	Basic structure of an HTML5 document, Creating an HTML5 document, Mark up Tags, Heading-Paragraphs, line Breaks	
	1.2	HTML5 Tags - Introduction to elements of HTML, Working with Text, Lists, Tables and Frames, Hyperlinks, Images and Multimedia	
	1.3	HTML Forms and other HTML5 controls.	
	1.4	Self-Learning : HTML5 based game development	
2		**Designing Static Web Pages**	04
	2.1	Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Lists and Tables, CSS Id and Class, Box Model (Introduction, Border properties, Padding Properties, Margin properties)	
	2.2	CSS Advanced: Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector	
3		**Client side scripting**	10
	3.1	**JavaScript -** Introduction to JavaScript, Lexical Structure, Types, Values, Variables, Expressions and Operators, Statements, Objects, Arrays, Functions, Pattern matching with regular expressions, JavaScript in Web Browsers, The Window object, Scripting Documents, Scripting CSS, Handling Events, Accessing CSS from JavaScript	
	3.2	**ReactJS**- Introduction to ReactJS, JSX, Class, Component, Props, Events, Conditionals, Lists, Forms, Router, Memo, CSS styling, Sass Styling, React Hooks	
		Self-Learning : UI/UX-SCSS, Typescript, Frontend-Angular, Backend-express	

4		**Bootstrap**	05
	4.1	Introduction to Bootstrap, downloading and installing Bootstrap.	
	4.2	The Grid System, CSS Foundations, Navigation Systems, JavaScript Effects. Bootstrap Customization-Combining Elements in Bootstrap, Customizing by Components, Plugins, and Variables	
5		**Server side-scripting**	05
	5.1	Introduction to PHP, PHP Tags, Adding Dynamic content, Accessing form variables, Identifiers, user-declared variables, Data types, Constants, Operators.	
	5.2	Control structures, Conditionals, Iteration constructs, Using arrays, string manipulation and regular expressions, reusing code and writing functions.	
	5.3	Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP. Cookies, Sessions, and Authentication, PHP-NoSQL Database connectivity e.g. PHP-MongoDB connectivity, NodeJS	
6		**Web Development Framework**	10
	6.1	MVC architecture - Introduction and applications	
	6.2	Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and other Assets, Talking to the Database, Model Relations, Scopes, and other Advanced Features, Integrating Web Forms, Authenticating and Managing Your Users, Deploying, Optimizing and Maintaining Your Application	
		Self-learning: Django Framework, Interactive web sites, web based information system, blogs, social networking sites, REST API and methods	
		Total	39

Textbooks:	
1	Ralph Moseley , M.T. Savliya , Developing Web Applications, Willy India, Second Edition
2	Web Technology Black Book, Dreamtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4	Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
5	Jennifer Kyrnin, ―SAMS Teach Yourself Bootstrap in 24 hours, 1st edition, Pearson Education.
6	Martin Bean, ―Laravel 5 Essentials, PACKT Publishing Ltd
7	Kirupa Chinnathambi, ―Learning React, Addison-Wesley Professional
Reference Books:	
1	Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, ―Internet and World Wide Web - How To Program‖, Fifth Edition, Pearson Education, 2011.
2	Achyut S Godbole and Atul Kahate, ―Web Technologies, Second Edition, Tata McGraw Hill, 2012.
3	Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013.
4	David Flanagan, ―JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011

5	Steven Holzner, ―The Complete Reference – PHP, Tata McGraw Hill, 2008
6	Mike Mcgrath, ―PHP & MySQL in easy Steps, Tata McGraw Hill, 2012.
7	J. Millman and A. Grabel, ―Head First HTML and CSS, 2nd edition, O‟ Reilly.
8	Ben Frain, ―Responsive Web design with HTML5 and CSS3, PACKT Publishing Ltd.
9	L. Welling and L. Thomson, ―PHP and MySQL Web Development, 4th edition, Adison Wesley Professional.

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Course Code:	Course Title	Credit
ELDO8013	Advanced Power Electronics	03

Prerequisite:	
1	Electronic Devices and Circuits (ELC302)
2	Electrical Network Analysis (ELC304)
3	Power Electronics (ELC701)
Course Objectives:	
1	To make students understand and appreciate analytical approach for design of power electronic systems.
2	To make students ready for research and development-oriented jobs in academia and industry by
3	Introducing recent research advancements in power electronic converters and their applications.
Course Outcomes:After successful completion of the course students will be able to:	
1	Apply mathematical modeling concepts to power electronic systems
2	Understand unique nature of computer simulations of power electronic systems
3	Understand new topologies of DC-AC inverters like multi-level and 4-leg inverters
4	Gain in-depth knowledge of AC voltage controllers
5	Understand various issues involved in parallel operation of inverters as part of the distributed generation system
6	Be aware of the vital role played by power electronic converters in distributed generation and smart grids

Module		Content	Hrs
1		Analysis of Power Devices	**4**
	1.1	Power transistor, Power MOSFET, SCR, IGBT, design of driver circuits for SCR, BJT, IGBT, MOSFET, selection criteria for switching devices.	
	1.2	EMI-EMC issues, protection circuits: Anti saturation protection for BJT and IGBT, overload protection, thermal protection.	
2		Power Electronic Converters and Systems	**6**
	2.1	Switching Voltage Regulators Introduction; Linear power supply (voltage regulators); Switching voltage regulators; unidirectional and bidirectional core excitation.	
	2.2	Review of basic dc-dc voltage regulator configurations Buck, Boost, Buck-Boost converters, Flyback converter, Bidirectional Converter (BDC) and their analysis for continuous and discontinuous mode	
3		**Modeling and Control of Power Electronic Systems**	**6**
	3.1	Concept of zero-order hold (ZOH), first-order hold (FOH) and second-order hold (SOH) elements, energy factor, models of AC-DC,DC-AC, AC-AC and DC-DC converters as simple ZOH, FOH andSOH, PI control for ACDC converters.	
	3.2	PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis.	
4		**Power Electronic Converters**	**8**
	4.1	Introduction to 3-phase supply; 3-phase uncontrolled and controlled rectifier; 3-phase inverter.	
	4.2	Modeling and control of inverters: State space model of various dc to dc converters, state space averaging techniques, small signal analysis, transfer function, feedback control, compensator design, voltage mode control, current mode control.	
	4.3	Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques), neutral point clamped inverter, study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters:	

		droop, and master and slave control.	
5		**Grid Interface of Renewable Energy Sources**	**8**
	5.1	Inverter interfacing control strategies for transferring wind and solar energy to grid, instantaneous power theory, reactive power control, synchronization with grid using phase-locked loop.	
	5.2	Concept of distributed generation system, microgrids, smart grids. Smart Grid Control.	
6		**Electric Motor Drives**	**7**
	6.1	Review of separately excited DC motor, Induction motor and Permanent magnet Synchronous motor (basic principle, equivalent circuit, speed-torque characteristics). Criteria for selecting drive components.	
	6.2	Single phase and three phase DC drives. Voltage and frequency control drive for Induction motor.	
		Total	**39**

Textbooks:	
1	N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.
2	M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.
3	P.S. Bhimbra, Power Electronics, Khanna Publishers, 2012.
4	M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw Hill
Reference Books:	
1	P.C. Sen, Modern Power Electronics, Wheeler publications.
2	Ramamurthy, Thyristor & Their Applications.
3	S. Shrivastava, Power Electronics, Nandu publications, Mumbai.

Internal Assessment:
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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

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Course Code:	Course Title	Credit
ELDO8014	**Virtual Instrumentation**	**3**
Prerequisite:		
1		
Course Objectives:		
1	To study graphical programming language for creating simulation and custom applications that interact with real-world data or signals in fields of science and engineering.	
Course Outcomes: After successful completion of the course students will be able to:		
1	Design logical operations, using Graphical programming language.	
2	Develop customized virtual instruments and represent them in required format with user friendly graphical programming software for LOOPS like FOR LOOP, WHILE LOOP etc.	
3	Understand how to plot the generated data and also able to export the data outside the programming environment.	
4	Study the data acquisition card or simulated software module and make user interface in the field of engineering.	
5	Describe the concepts of different analysis tool.	
6	Design and develop real world applications using graphical programming software.	

Module		Content	Hrs
1		**Introduction**	**4**
	1.1	Virtual Instrumentation: Historical perspective, block diagram and Architecture of a virtual instrument	
	1.2	Conventional Instruments versus Virtual Instruments	
	1.3	Data-flow techniques, graphical programming in data flows.	
2		**VI Programming Techniques**	**10**
	2.1	Data types, VIs and sub-VIs, Structures (For, While etc.) arrays, clusters, shift registers, case and sequence structures, formula nodes.	
	2.2	Debugging techniques	
3		**Plot and Export Data**	**4**
	3.1	Strings, File I/O	
	3.2	Plotting data: graphs and charts, report generation.	
4		**Data Acquisition**	**6**
	4.1	Introduction to data acquisition on PC, Digital I/O, Counters and Timers	
	4.2	Software and Hardware installation, Calibration, Resolution	
	4.3	Data acquisition interface requirements, VISA programming	
5		**Measurement Analysis Tools**	**6**
	5.1	Use of analysis tools for measurement of max, min, peak to peak voltage, Time period of signal, correlation methods	
	5.2	Design of oscilloscope, digital multimeter.	
6		**Applications**	**9**
	6.1	System development for a process. Development of Graphical User Interface (GUI).	
	6.2	Implementation of various controllers (ON/OFF control, PID control) for a process.	

			Total	39

Textbooks:	
1	Rober Bishop, "Learning with LabVIEW TM 7 express", Pearson Education, 2005.
Reference Books:	
1	Jovitha Jerome, "Virtual Instrumentation", PHI, 2018.
2	Gupta S, "Virtual Instrumentation Using LabVIEW", Tata McGraw Hill Publishing Company Limited.
3	Lisa K. Wells &Jettrey Travis, "LabVIEW for everyone", Prentice Hall, New Jersey, 1997.
4	LabVIEW users manual.
Website	
1	www.ni.com

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

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Course Code:	Course Title	Credit
ELDO 8021	Next Generation Networks	3
Prerequisite:		
1	Computer Communication Network	
2	Digital Communications	
3	Principles of Communication Engineering	
Course Objectives:		
1	To learn about Personal Area Networks	
2	To understand Vehicular Ad-hoc Networks	
3	To explore WiMAX standards	
4	To learn Networking with IPv6	
5	To understand the need for 5G	
Course Outcomes: After successful completion of the course students will be able to:		
1	Appreciate the requirement of Personal Area Networks	
2	Analyze the need for VANET	
3	Understand the requirement for WiMAX	
4	Evaluate networking with IPv6	
5	Comprehend the need for 5G	

Module No.	Unit No.	Contents	Hrs.
1		Personal Area Networks	6
	1.1	Bluetooth Ad Hoc Network :Introduction, Bluetooth network structure, Bluetooth protocol stack , Bluetooth physical layer, Bluetooth MAC layer, Modified versions of Bluetooth, Advantages, drawbacks and applications	
	1.2	Wireless Personal Area Networks: Low Rate and High Rate: ZigBee Technology, IEEE 802.15.4 LR-WPAN Device Architecture, IEEE 802.15.3a — Ultra WideBand, Advantages, drawbacks and applications.	
	1.3	Wireless Sensor Networks: Introduction to Wireless Sensor Networks, Wireless Sensor Network Model, Sensor Network Protocol Stack.	
2		VANET	8
	2.1	Introduction to Vehicular Adhoc Network Traffic Monitoring, Causes of Congestion, Commonly used sensor technology, Detection Methods.	
	2.2	Modes for Traffic Flow and Vehicle Motion Models for longitudinal Vehicle movement, Lane Change situations, Simulating Vehicle to Vehicle and Infrastructure to Vehicle Communications.	
	2.3	Networking Issues in VANET: Routing Protocols for VANET	
3		WiMAX standards	6
	3.1	WiMAX architecture, WiMAX physical layer, WiMAX MAC layer	
	3.2	WiMAX security Aspects	
4		Networking with IPv6	8
	4.1	Routing with IPv6 :OSPF for IPv6, PIM-SM & DVMRP for IPv6 IPv4/IPv6 Transition Mechanism	
	4.2	Tunneling: Automatic Tunneling & Configured tunneling	
5		5G Technology	6

	5.1	5 G : Difference between 4G and 5G, 5G Architecture, Planning of 5G Network	
	5.2	Quality of Service, Radio Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization.	
	5.3	Limitation of 5G and Need for 6G	
6		Case Studies	5
	6.1	NGN Networks: Perspectives and Potentials, Virtual Global Exhibition. Virtual Classroom, e-Education and Experimental Laboratory, Virtual Corporate Environment, Virtual Home, Virtual Hospital.	
		Total	39

Textbooks:	
1	Vijay Garg, Wireless Communications & Networking, The Morgan Kaufmann Series in Networking
2	Hassnaa Moustafa and Yan Zhang, Vehicular Networks :Techniques, Standards and Applications, Auerbach Publications,2019
3	Upena Dalal , Wireless Communication and Networks , Oxford Higher Education
Reference Books:	
1	K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India,.
2	Deven Shah , Ambavade, ―Advanced Communication Networking‖
3	Beherouz A Forouzan , ―TCP /IP Protocol Suite‖ , Tata McGraw Hill Education ,4th edition

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code:	Course Title	Credit
ELDO8022	**Industrial Internet of Things**	**03**
Prerequisite:		
1	Internet of things, Web technologies, Industrial Automation	
Course Objectives:		
1	To learn and understand the importance of IoT in Industrial applications.	
2	To understand how IoT has become a game changer in the new economy where the customers are looking for integrated value.	
3	To apply the IoT concepts in building solutions to Industrial problems.	
4	To learn and understand the tools and techniques that enable IoT solutions and Security aspects.	
Course Outcomes: At the end of this course the student will be able to:		
1	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security	
2	Explore IoT technologies, architectures, standards and regulation	
3	Apply IoT Protocols for Industrial automation/applications	
4	Explain the need of IoT in Industrial environment & Security aspects of IoT	
5	Explain the new concepts for data logging and analytics	

Module		Content	Hrs
1		**Introduction & Architecture**	**3**
	1.1	What is IIoT and the Connected world?	
	1.2	SCADA Vs. IoT	
	1.3	Architecture of IIoT	
	1.4	IoT node, Challenges of IIoT	
2		**IIoT Components**	**8**
	2.1	Fundamentals of Control System: Introduction, Components, Closed loop & Open loop system.	
	2.2	Sensors and Interfacing: Introduction to Sensors, Classification, Role of Sensors in IIoT, Various types of Sensors, Special requirements for IIoT sensors	
	2.3	Role of Actuators, Types of Actuators.	
	2.4	Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M etc.	
3		**Communication Protocols**	**8**
	3.1	RS485/RS232 Communication Protocols MODBUS RTU Vs. MODBUS TCP/IP Importance of using MODBUS in IIOT Applications	
	3.2	Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID	
	3.3	Protocols converters : USB to RS485, 4-20mA to RS485, MQTT vs. MQTTS	
	3.4	Cloud / Server architectural requirements for IIOT Applications	
4		**Control & Supervisory Level of Automation**	**6**
	4.1	Programmable logic controller (PLC)	
	4.2	Control signal introduction, Digital I/O, Analog I/O, 4-20mA systems	
	4.3	Supervisory Control & Data Acquisition (SCADA)	

	4.4	Need of Human machine Interface (HMI) in Automation	
	4.5	Basics of Enterprise Resource Planning (ERP) System & Manufacturing Execution System (MES)	
5		**Security Issues in IIOT**	**8**
	5.1	Vulnerabilities of IoT, Types of attacks, defense against attacks, Privacy, Security requirements, Threat analysis	
	5.2	IoT Security tomography and layered attacker model,	
	5.3	Security model for IoT, Network security techniques Management aspects of cyber security.	
6		**Applications of IIOT**	**6**
	6.1	Case study of Chemical Tank Level Monitoring application through HMI	
	6.2	Case study on IIOT cloud integration with Microsoft Azure, AWS & other cloud services like Ubidots or Thingspeak, Case study on AWS Industrial IoT Predictive Maintenance	
		Total	**39**

Textbooks:	
1	Introduction to Industrial Internet of Things and Industry 4.0, 1st Edition, Sudip Misra, CRC Press.
2	Practical Industrial Internet of Things Security: A practitioner's guide to securing connected Industries, Sravani Bhattacharjee.
3	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Willy Publication.
	Architecting the Internet of Things, by Florian Michahelles, Springer, 2011.
Reference Books:	
1	The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.), Springer Publication.
2	Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat , Springer Publication.
3	Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (Editor), Springer Publications.

Useful additional resources:	
1	https://aws.amazon.com/iot/solutions/industrial-iot/
2	Security of the Internet of Things:Vulnerabilities, Attacks and Countermeasures by Ismail Butun, Member, IEEE, Patrik Osterberg, ¨Member, IEEE, and Houbing Song, Senior Member, IEEE

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code:	Course Title	Credit
ELDO 8023	**System on Chip**	**03**
Course Objectives:		
1	To know the basic concepts of System on Chip	
2	To know the basic concepts of System on Chip	
3	To be familiar with basics of SoC Customization and Configuration	
Course Outcomes: After successful completion of the course students will be able to:		
1	Understand overview of SoC System Architecture	
2	Select Processor for a SoC	
3	Develop knowledge of memory and interconnect design for SoC	
4	Apply the knowledge of design tradeoffs for optimized SoC performance	
5	Describe SoC Customization and Configuration	

Module		Content	Hrs
1		**Introduction to SoC and System Approach**	**8**
	1.1	Overview of System Architecture: Components of a System: Processor, Memory and Interconnects, Basic SoC Model, Hardware and Software: Programmability versus Performance	
	1.2	Processor Architectures: Functional view approach, Architectural View approach	
	1.3	Memory and Addressing: Architecture of Memory and Memory for SoC operating Systems	
	1.4	System Interconnects: Bus based and NoC based interconnect Approach, An Approach for SOC Design	
2		**Processor Architecture for SoC**	**6**

	2.1	Processor Selection: Overview and Processor Core Selection	
	2.2	Basic concepts in Processor Microarchitecture; Basic elements in Instruction Handling: Decoding, Bypassing and Executionunit	
	2.3	Introduction to Robust Architectures	
3		**Design Trade off and minimizing delays and cost**	**6**
	3.1	Design Tradeoff: Time, Area and Power, reliability and Configurability	
	3.2	Buffers: Minimizing Pipeline Delays	
	3.3	Branches: Reducing Branch Cost	
4		**Memory Design**	**8**
	4.1	Overview: Outline for Memory Design, SoC external Flash Memory And internal memory placement, Size tradeoff	
	4,2	Scratch pad and Cache Organization: Write Policies, Strategies for Line Replacement at miss time, Multilevel Caches, L1-Icache L1- Dcache	
	4.3	Memory Address Translation: Translation of Virtual to Real, TLB	
5		**Interconnect Design**	**6**
	5.1	Overview of Interconnect Architectures	
	5.2	Bus Architectures: Arbitration, Bridge and Bus Structure	
	5.3	Standard Buses: AMB Aand Core Connect Bus	
6		**Customization and Configuration**	**5**
	6.1	Introduction: Estimating Effectiveness of Customization	
	6.2	Overview of SoC Customization	
	6.3	Customizing Instruction Processors	
	6.4	Introduction to Reconfigurable concept	
		Total	**39**

Textbooks:	
1	Michael J. Flynn and Wayne Luk, Computer System Design System-on-Chip, Wiley India Pvt. Ltd.
2	SteveFurber, ARM System on Chip Architecture,2ndEdition,2000, Addison Wesley Professional
Reference Books:	
1	Ricardo Ries, Design of System on a Chip: Devices and Components, 1stEdition, 2004, Springer
2	Jason Andrews, Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Newnes, BK and CDROM.
3	Prakash Rashinkar, Peter Paterson and Leena Singh L, System on Chip Verification Methodologies and Techniques, 2001, Kluwer Academic Publishers

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
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2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
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4	Any three questions out of five needs to be solved.

Course Code:	Course Title	Credit
ELDO 8024	IC Technology	3

Preamble:	
1	This course enables students to understand semiconductor manufacturing requirements and various techniques for crystal growth and will get clear understanding of various MOS fabrication processes along with CMOS fabrication process flow. Students will be able tod sign layouts of MOS based Circuits.
Course Objectives:	
1	To provide knowledge of fundamental building blocks of IC fabrication
2	To design basic CMOS circuit layouts using Lambda design rules
3	To be familiar with various VLSI technologies and novel devices
Course Outcomes:After successful completion of the course students will be able to:	
1	Explain crystal growth techniques
2	Demonstrate a clear understanding of various MOS fabrication processes
3	Discuss CMOS fabrication process flow
4	Design basic CMOS circuits with layout
5	Study various VLSI technologies and novel devices

Module		Content	Hrs
1		**Semiconductor manufacturing requirements and Crystal growth techniques**	**6**
	1.1	Semiconductor Manufacturing: Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering	
	1.2	Crystal growth techniques: Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2		**Semiconductor Device Fabrication Processes-1 (Epitaxy, Oxidation and Deposition)**	**8**
	2.1	Epitaxy: Introduction to Epitaxy concept	
	2.2	Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality Device Isolation: LOCOS, Shallow Trench Isolation (STI)	
	2.3	Deposition: Physical Vapor Deposition-Evaporation and Sputtering systems, Chemical Vapor Deposition: APCVD, LPCVD, PECVD systems	
3		**Semiconductor Device Fabrication Processes-2 (Impurity incorporation, Pattern Transfer and Contacts)**	**10**
	3.1	Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems Ion Implantation: Penetration range-Nuclear& Electronic stopping and Range, Implantation damage, Annealing-Rapid thermal annealing, Ion implantation systems.	
	3.2	Etching: Basic concepts and Classification Lithography: Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.3	Metallization and Contacts: Introduction to Metallization, Schottky contacts and Ohmic contacts	
4		**CMOS Process Flow and Design rules**	**8**
	4.1	CMOS Process Flow:N well, P-well and Twin tub, CMOS Latch Up	
	4.2	Design rules: Layout of MOS based circuits (gates and	

		combinational logic), Buried and Butting Contact	
5		**VLSI Technologies**	**8**
	5.1	SOI Technology: SOI structures, fabrication methods and features	
	5.2	Advanced Technologies: low κ and high κ, BiCMOS, Introduction to MESFET Technology	
6		Novel Devices	**6**
	6.1	Multigate Devices: Various multigate device configurations double gate, triple gate (FinFET) and Gate All Around (Nanowire).	
	6.2	Nanowire: Concept, VLSI method of fabrication, Nanowire FETs	
	6.3	CNT FET: Introduction to Graphene and CNTFET structure	
		Total	**39**

Textbooks:	
1	James D. Plummer, Michael D. Deal and Peter B. Griffin, ―Silicon VLSI Technology‖, Pearson, Indian Edition.
2	Sorab K. Gandhi, ―VLSI Fabrication Principles‖, Wiley, StudentEdition
Reference Books:	
1	Stephen A. Campbell, ―The Science and Engineering of Microelectronic Fabrication‖, Oxford University Press, 2nd Edition
2	G. S. May and S. M. Sze, ―Fundamentals of Semiconductor Fabrication‖, Wiley, First Edition
3	Kerry Bernstein and N. J. Rohrer, ―SOI Circuit Design Concepts‖, Kluwer Academic Publishers, 1st edition.
4	Jean-Pierre Colinge, ―FinFETs and Other Multigate Transistors‖, Springer, 1st edition

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Lab Code	Lab Name	Credit
ELL 801	Industrial Automation Lab	1

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

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Study/ Simulate proportional, integral and derivative controller
2	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic
3	Develop PLC programs for minimum 2 applications e.g Heating, mixing, car parking , elevator system , traffic control system etc.
4	Simulate analog and digital function blocks of DCS using Functional Block Diagram
5	Develop graphical user interface (GUI) for any continuous or batch process plant

6	Develop GUI for any one application using SCADA software
7	Assignment/Exercise based on Automation Fundamentals
8	Assignment/Exercise based on DCS Displays and hierarchical computer control
9	Assignment /Exercise based on SCADA
10	Assignment/Exercise based on Database and Alarm management/MES/ERP
11	Assignment/Exercise based on Safety Instrumented System

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 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)
Continuous assessment exam	
1	Based on the subject and related lab of ELL801and ELC 801

Lab Code	Lab Name	Credit
ELL 802	Micro-Electro-Mechanical-Systems Laboratory	1

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

Suggested Experiments: Students are required to complete at least 10 experiments.

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

10	Simulate the dynamic behaviour of pressure sensor.
	Faculty members are required to take Case study of MEMS based devices and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices under case study.

Term Work:	
1	Term work should consist of at least 7 experiments and 1 case study.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures 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)
Continuous assessment exam	
1	Based on the subject and related lab of ELL802and ELDO801

Lab Code	Lab Name	Credit
ELL802	**Web Design Lab**	**1**

Prerequisite: Basics of programming languages, knowledge of HTML & computer networks.

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

Term Work:	
1	Term work should consist of at least 8 experiments.

2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures 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)
Continuous assessment exam	
1	**Based on the subject and related lab ELL802 and ELDO801**

Lab Code	Lab Name	Credit
ELL 802	Advanced Power Electronics lab	1

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	To study speed control of a DC motor using DC drive.
2	To study speed control of a DC motor using AC drive.
3	To study step up /step down chopper.
4	To demonstrate high frequency induction heating using a Multisim simulator.
5	To study 3 phase half controlled rectifier with R load.
6	To simulate a sinusoidal PWM inverter using Simulink.
7	To study speed torque characteristics of AC drive using MATLAB.
8	To study grid connected single-phase inverters.
9	To study cascaded H-bridge multilevel inverters.
10	To study closed-loop control of buck converters.

Note: All the experiments can be performed online using simulation softwares. Free simulation software Scilab can be used to perform the experiments.

Term Work:	
1	Term work should consist of at least 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures 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)
Continuous assessment exam	
1	Based on the subject and related lab of ELL802and ELDO801

Lab Code	Lab Name	Credit
ELL 802	Virtual Instrumentation Lab	1

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

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	**Name of the Experiment**
1	To develop a VI to calculate speed, convert degree Celsius to Fahrenheit.
2	To develop a Sub VI to implement Half adder and Full Adder.
3	To develop VI using FOR and WHILE loop to add 10 numbers, calculate Factorial of a given number.
4	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.
5	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.
6	Applications of Graphical Programming Software in digital

	eletronics - binary to decimal conversion etc.
7	To develop a VI for storing all the points of simulated signal using File I/Os
8	Build a VI to plot circle in XY graph, generate and plot random numbers on chart, different colors in an intensity graph etc with graph, chart properties and options.
9	Measurement of AC/DC voltage and current using DAQ cards.
10	Develop the VI to turn LEDs ON/OFF using DAQ devices (Arduino, Raspberry Pi etc.)
11	Applications of Graphical Programming Software in control - simulate first and second order system response, effect of damping factor etc.
12	To create VI to simulate traffic light controlusing Sequence structure.

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

Note: All the experiments can be performed online using simulation softwares. Free simulation software Scilab can be used to perform the experiments.

Term Work:	
1	Term work should consist of at least 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks Laboratory work (Experiments/assignments) : 10 Marks Laboratory work (Journal) : 10 Marks Attendance (class Room plus Lab Practice) : 05 Marks
Continuous assessment exam	
1	Based on the subject and related lab of ELL802and ELDO801

Course Code:	Course Title	Credit
ISP 801	Major Project II	6
Course Objectives:		
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.	
5	To enable the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a social real life problem or an issue, and mapped with 17 sustainable development goals (SDGs) to transform our world via a substantial piece of work which is to be carried out over an extended period.	
Course Outcomes: On successful completion of course learner/student will be able to:		
1	To undertake problem identification, formulation and design engineering solutions to social problems following a systematic approach.	
2	Apply knowledge and skill to solve societal problems in a group.	
3	Develop interpersonal skills to work as a 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 life-long 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.

The 17 sustainable development goals (SDGs) to transform our world:

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to achieve the Goal

Guidelines for Assessment of Major Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each 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 logbook: 30
  - Marks awarded by review committee : 30
  - Quality of Project report : 40

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

- In VIII semest er expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - ❖ First review is based on readiness of building working prototype to be conducted.
  - ❖ Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

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

1. Cost effectiveness and Societal impact
2. Full functioning of working model as per stated requirements
3. Effective use of skill sets
4. Effective use of standard engineering norms
5. Contribution of an individual's as member or leader

6. Clarity in written and oral communication

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations, having experience of more than five years approved by head of the Institute.
- **Students shall be motivated to publish a paper based on the work in Conferences/students competitions**.

Major Project-II 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 diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

Project Report Format:

At the end of semester, a project report written in Latex should be submitted by the group. It should preferably contain at least following details,

i. Abstract

ii. Introduction

iii. Literature Survey

a) Survey of Existing system

b) Limitations of Existing system or research gap

c) Problem Statement and Objective

d) Scope

iv. Proposed System

a) Analysis/Framework/ Algorithm

b) Details of Hardware & Software

c) Design details

d) Methodology (your approach to solve the problem)

v. Implementation steps

vi. Conclusion

vii. References in standard format

Continuous Assessment:
A student shall be assessed based on various rubrics associated with the subject.

Oral &Practical examination of Project-II should be conducted by Internal and External examiners approved by Academic council/ Exam cell. Students have to give presentation and demonstration on the Project-II.